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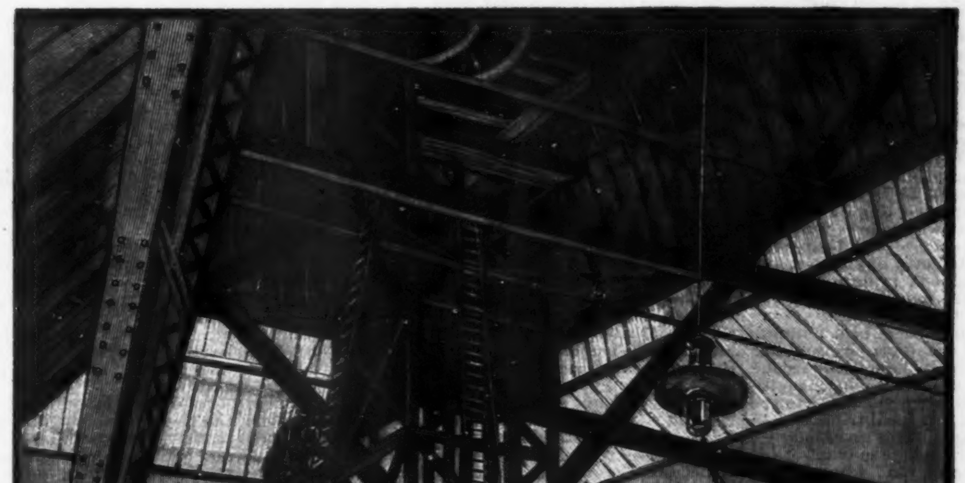
A SINGULAR ELEVATOR ACCIDENT.

ACCIDENTS from the falling of elevator cages are common enough, but a serious catastrophe caused by the ascent of the cage is rare. A terrible accident of this nature occurred in the mines at Drocourt, France, Jan. 22. The cage, in which were twenty-eight workmen, was rising very rapidly when the man in charge, wishing to apply the brake, found to his terror that it did not operate. The cage mounted to the enormous pulleys around which the cables wind, there was a violent shock, and the cage was partially destroyed, demolishing the iron frame which supported the pulleys.

Two foremen were killed instantly, four young workmen died a few hours later, and nineteen others were more or less seriously injured. Only three escaped unhurt.

Delcolle, the man in charge at the time of the accident, was put under arrest. To clear himself he claimed that the brake was in bad condition, as the blow-off arrangement had been changed some days before by order of the administration, and a certain quantity of water must have remained in the cylinder, preventing the operation of the machinery. Delcolle added that on account of the illness of a comrade who had the influenza, he had worked twenty-four consecutive hours, and finally that he had been ordered by the engineers to increase the speed of the cage when carrying up workmen or coal. The truth of his defense had to be left to the investigation of the coroner's jury. —*Le Monde Illustre.*



A SINGULAR MINE ACCIDENT AT DROCOURT.

THE SOCIAL SIDE OF THE ELECTRIC RAILWAY.*

By T. C. MARTIN.

A MONTH or two ago we had the pleasure of listening in this hall to a most interesting paper by Mr. S. Dana Greene on the development of electrical traction. I had previously promised the secretary of the society a paper on the same subject, but I felt it would be useless for me to traverse the same ground again. Mr. Greene spoke with authority, and not as one of the newspaper scribes, and I was glad to learn from him and accept most of his conclusions. I recognize the fact, however, that he dealt with the topic mainly on its technical side, as a specialist of experience, and that there was still a very important branch of the subject on which a few helpful words might be said—namely, the relation of the electric railway to the public and to social conditions generally.

Few of us stop to think of the enormous difference that facilities for travel make in our lives. I do not refer to the opportunities and appliances for long journeys, but to the simple everyday transportation that we calmly accept as a prime condition of existence. It is probably safe to say that every one of us came here to-night, and will go home, without depending on our legs to make the trip. But this is altogether modern, and to the generation immediately preceding ours would have seemed as unlikely as that, from total lack of exercise, our legs should become atrophied and own no function of pedestrianism. Yet now that we have enjoyed the advantages that the means of artificial locomotion already gives us, we want more. The Harlemite does not consider it rapid transit unless he goes from City Hall square to the rocks and goats above Mount Morris Park in an hour and a half, and his discontent with the steam railway on stilts becomes daily diviner and deeper. The citizen of Brooklyn is not satisfied to be reduced to a despairing calculation as to whether he is after all better off by being jammed and gouged on the bridge than by balancing on one trodden toe upon the old ferry boats before he can reach his little vineclad, mortgaged home at the back of the east end. And as for the Jersey man, it is needless to say that of all the ills of his wearisome daily travel, he is able to commute only one. Still, we are infinitely better off in choice of location for our homes than were the people of Manhattan before us, who knew not the elevated railroad, and never gladdened their eyes with the majestic spectacle of the platform of Brooklyn bridge at a quarter to six on a wet March night, with the cable broken down. If you will take the trouble to invite the candid opinion of the "oldest inhabitant" as to the vanished Broadway stages, the early street cars, and the ancient ferries, you will learn that we have scored a distinct advance. That is why we all want something better.

This is a barbarous age we live in, but we have a foretaste of the civilization that awaits our descendants. We are beginning to learn that luxury is a relative term. A hundred or even fifty years ago there was no such thing as luxurious travel. Washington came to New York to be installed as president, in a manner that a fastidious drummer might now despise. De Quincey was willing to give five years of his life for an outside place on a stage coach that carried down from London through the English counties the news of a great event. We save our five years and our health, and get all the thrill we want, by blocking up the sidewalk on Park Row, and reading the newspaper bulletins as they cover one another on the boards like successive waves of emotion, rolling in from the unseen but tangible, throbbing distances. We know what the past was. The blizzard of two years ago brought us down to the normal average conditions of semi-savagery in locomotion as it prevailed prior to the introduction of the steam road, conditions that need all the glamor of the romancist to be made even tolerable as a picture to the New Yorker who boards the Pullman special for the South, and has had his pleasure in Florida, and returned, before the storm that was in progress when he left has gone eastward to discover Europe.

What steam has been to long distance travel in replacing the stage coach and the sail, electricity is in turn to urban travel in replacing the horse car and the cable road. Later in this paper I will indicate the manner in which electricity may sooner or later realize the best and brightest promises made on behalf of the transcontinental steam railroad; but our first thought is as to electrical travel within towns and cities, and the manner in which it affects social relations, by modifying as with the harlequin wand of transformation all the conditions to which we have heretofore been subjected.

In speaking of this great advance of electricity as applied to the comfort and convenience of man, I do not wish to be understood as praising a perfect thing. We are in the early stages of practical electric locomotion. The pioneer work has been done by young men, still among us, much too near their salad days to fall into the reminiscent vein. It is barely three years ago that I had myself the honor of bringing before the American Institute of Electrical Engineers the first statistics published on American electrical railways, when I seized with brazen audacity upon every bit of a track that could possibly bear inclusion as a road. I would be understood rather as appearing in advocacy of an improvement, in many respects crude, but which is not yet appreciated even as it stands. We of the electrical industry have a great duty in this respect, of preaching the advantages of electric locomotion, in season and out of season; and by our persistency we can help the art along. The phrase that good wine needs no bush was not coined by an American advertiser, and the idea that electricity will make its own way is not justified by the history of any great invention that has yet subserved the needs of mankind. Electric locomotion is, however, ready for adoption at an opportune moment. It offers itself at a time when everything else that has been tried for urban travel has revealed objections and disadvantages, the more keenly realized because of our higher conceptions of what such travel may be. It is a singular principle that as a system or device reaches perfection, something comes forward to supersede it. The horse coach was at its height of speed and comfort when the steam engine challenged it. The white-sailed China clipper was never swifter than when it lowered its flag to the conquering steamship. And so to-day, the horse, the cable, and the steam locomotive have shown the utmost that they can do, just as the electric motor rolls to the front and takes the stage, as the means best suited to the peculiar requirements of passenger traffic in modern towns and cities. I do not say that it will banish these competitors from the scene, but I do maintain that its superiority will quickly gain it the decided preference. I am always suspicious of an invention or

* A paper read before the New York Electrical Society, March 12, 1890.

improvement that is going to knock out everything else, like a charge of dynamite. History is against any such phenomenon. What we do see is a limitation of the antecedent methods and appliances to the sphere within which they are most useful and economical. The old is restricted to its proper place and function as by a ring of fire; the new goes on making its own kingdom until at last its boundaries of achievement are also determined. Thus, as Tennyson puts it, "God fulfills himself in many ways, lest one good custom should corrupt the world."

The first of the social considerations to which I would direct notice is the effect on the public of the adoption of electricity as a motive power for street railways. The struggle for supremacy in urban passenger work has already narrowed down strictly to the horse, the cable, and the electric motor. As everybody knows, steam motors are completely out of favor for use within city limits. Their glorious record of half a century in long distance travel does not deceive any one dwelling in a city as to the insuperable defects and nuisances of noise, smell, smoke, dust, steam escape, oil drippings, etc., which may be more readily tolerated, remotely, in the open country. Perhaps I am wrong, but I believe we shall not see any more steam roads in New York, and that, imposing as are the statistics of the Manhattan elevated system of to-day, they will be eclipsed in a very few years by those of the newer form of electric locomotion. And may not the same be said as to the horse? There are now close upon 15,000 horses engaged in hauling street cars around this city. It is high time that every one of these was dispensed with, as well for its own sake as for that of the city, whose air it assists in polluting and whose population it aids in driving into exile.

Allowing an average space of 40 square feet to each horse, or a stall 9 feet by 4½ feet, we find that in stall space alone those 15,000 horses occupy 600,000 square feet of floor in their stables. These horses are required to operate some 2,400 cars—an average of about 7 to the car if every car were in commission at once, which is not at all the case. But even if nearly all the cars were wanted, an average of 10 horse power each would be ample in the central station of an electrical plant, to bring us a liberal allowance of 25,000 horse power. But here comes in the remarkable though not unfamiliar fact that a steam plant will go into much less space than an animal power plant of equal capacity. Mr. C. J. Field, who is known to many of you as a constructing and mechanical engineer, informs me that his recent practice shows that a generating electrical plant for 20,000 horse power, to operate all the street cars of this city, could easily be placed in a building 100 by 150. The engines and the dynamos would be placed on the first floor, and the boilers on the second floor. The generators in such a plant would be multipolar, 500 horse power each, directly connected to the engines, and each would be of a vertical triple expansion type, of 500 horse power each. This gives only 1⅛ square feet to the horse power, and we may offset the space for feed, etc., by that for coal, etc. I have tested these figures by those of recent electric light stations in actual operation, and they are found to be very fair and reasonable. It might be objected that all the power would not be bunched in this way; but even with half a dozen generating stations of 2,000 horse power, there would only be an increase in space required of about 10 per cent. From this remarkable but strictly proper comparison, we can form an idea as to the economy of real estate, bearing in mind also the fact that horse car stables are generally wooden or brick sheds, only one or two stories in height, while an electric plant may be run up as high as an appartment house or an office building, just as ornate without, just as clean within.

Hence there can be no mistake in the statement that electricity is a direct boon to the urban population that clings to the city, loves the city life, and that, if crowded out from it into the country, suffers all the pangs of banishment. Indirectly, too, it is a further boon, because with horses a great portion of the district surrounding the car stables is also spoiled for human habitation. The whole region within what I would define as "the area of smell" is unsavory and unhealthy the year through, and the consequence is that while the taxing and renting value of it is lessened the death rate is run up. "Do not insult a respectable animal who has come from the country to do his share of the work of the world," says one authority, "and has brought with him the memory of the sweet hills and skies, at least, by immuring him in one of those cramped, rickety, rotten, slovenly, damp dungeons, where a dumb beast would lose his self-respect and his courage beneath an oppressive weight of miasma and hideous, gloomy, nasty confusion." And so say all of us, and all of us are glad to note a vast improvement in this respect. The stables are better ventilated now, as a rule, but the trouble is just there. If they were not so well ventilated, the neighborhood would be sweeter and would be fitter for human beings to live in. The poor die quicker, that the horses may suffer longer.

An objection I may anticipate is that, after all, such large generating plants would not be desirable, with their huge smoke stacks, their discharge of gases, etc., upon the atmosphere, their receipt of coal and their removal of ashes. I would reply that it is by no means necessary for the plants to be, as the stables must be, right upon the main lines of travel. They would, by decided preference, be located near the water's edge, out of the way. Moreover, the stacks would be, as they are to-day in large electric light plants, high enough to carry off all smoke or smell far beyond perception. Perhaps the familiar smoke stack is not an æsthetic object, but it can be made so. There are steeples in this town that, on the score of their beauty, are not fit to compare with smoke stacks near them.

Much that I have said under this head with respect to electricity applies to the cable. That system has been an immense advance in street car travel, and is destined to many years of usefulness yet. It is worthy of much praise, but it will not hold its own with electricity, simply because it is deficient in some things that electricity possesses to a pre-eminent degree. It has been a forerunner for electricity. It is not only enormously costly in its first installation, but has the disadvantage of being a unit. The whole of the road and all its power hangs by that one cable. If the cable be duplicated in the conduit, the expense is again so much the heavier, while the criticism as to risk still stands. Moreover, a cable car cannot go backward at its driver's will. Onward it must go, Mazeppa-like, strapped down to its carrier, no matter what unfortunate contingency impend, or what obstacles lie in its path. It cannot greatly vary its own speed. An electric car is so manageable that it will reverse in its own length or less. But the greatest trouble of all with the cable is that it is always the one thing, while there are very few towns or cities that are alike in offering just the rigid Procrustean conditions it meets. There are about 50 cities in the United States with a population of over 50,000, but there are between 700 and 800 street railway companies, if not more; so that even if all the places in the first category could justify the heavy expenditure on a cable system, there are hundreds of others unable to do so. We need not wonder, then, that at their last convention in Minneapolis the street railway men gave electricity such a hearty welcome, adopting the enthusiastic if not elegant language of a committee report, which said that it "filled the bill to perfection." Nor need we wonder that the street railway company in Minneapolis has just thrown aside an unused cable plant that cost $400,000, and is putting in electric cars and over 100 miles of electric road.

Why does electricity "fill the bill," and in a manner that interests the public? Well, for the reasons given already and for others. It is above all things flexible, plastic, protean. It can be applied in half a dozen different ways, and be absolutely safe for human life in any and all of them. The street railway may be equipped with an overhead system for supplying the current to the motors, and to that system, well built, with trim ornamental poles, lines well run and guarded, little or no objection can be offered. The air is God's own insulation; we know none better, none so cheap, and a wire is well insulated up aloft. The Bostonians, who are people setting no small store by their refined, acute, and cultivated taste, have adopted poles and wires in preference to the hideously ugly lattice work tunnels we have in New York to hold up our elevated roads, and I admire them for it. It is possible that Boston may have an elevated road, but if so it will be a handsome electric one. Or, if the overhead wire be objected to, as it may, there is the conduit system, which is fully able to give a good account of itself if well put in and plenty of money be spent on it. It is true that the wires are not exposed in the conduit system, but otherwise there is not much operative difference between it and the overhead methods. There may be difficulties in heavy, wet, or snowy weather, but we shall see them all overcome. Or should this or its modifications again be found fault with, there is the ideal storage battery system, where each starts out "on its own hook," an independent, self-contained unit. I don't exactly know why we call it the "ideal system." It is either within reach or beyond. If within reach, it is not "ideal," but ought, speaking from the public standpoint, to be adopted wherever there is actual need for it. It may be a trifle expensive, but that is certainly not one reason more why the public should do without it. It may be somewhat difficult to put and keep in order. "Coaches, Sammy," said the elder Weller, sententiously, to his son, "coaches is like guns—they require to be loaded with werry great care afore they go off," and that is about the case with the storage battery cars. But they do go off, and we know from the approval they have met with that they do hit the mark of popular approval, and that is one of the main things I am talking about to-night.

It is in one or other of these systems or modifications of them that electricity will become familiar to the public of this country in street railway work. It will, I think, be chiefly for a long time to come the overhead system, which is not costly to put up, is not expensive to maintain, can be operated economically at about half the running charges of animal power, and fully answer the requirements of the vast majority of our thriving, intelligent centers of trade and manufacture. All these methods are safe, and none of us ever heard, or expects to hear, that the currents of 500 volts they have employed have taken a single human life. The motor cars cannot "explode," the daily papers to the contrary notwithstanding.

They scatter no dust or ashes; they do not litter the streets with offensive refuse, but rather ozonize the air; they are pleasant to ride in, and they do not damage the paving. They require good tracks for their best operation, and naturally make their worst showing on the automatic mud sprinklers that so begutter the roadways in this city. But the roadbed between the tracks they never touch. It might as well be a continuous plot of flowers. In the outskirts of Boston some of the electric cars whose aerial wires run hidden between the overarching trees have their tracks laid down on a narrow green lawn for three or four miles; and at a remove of but a few feet it seems to the spectator as though the cars were gracefully skimming over the smooth grass in effortless flight, like low-darting, even-poised swallows.

I have just spoken of the outskirts of Boston, and this brings me to another important point wherein electric cars are an element making for the public good. They help a man to get further away from his business, and yet bring him nearer to it. "Rapid transit," by their means, is no longer a deceiving phrase, or the proud monopoly of one or two big cities. The smallest city in the country is at once given a command it never had before over the territory around it. The smallest storekeeper or the humblest clerk can revel in the sweets of rural life if he wish.

His electric car, running at 15 or 20 miles an hour, will give him more of home life, a few more golden minutes with the children in the morning, an earlier return to the wife at nightfall. The whole social atmosphere of the place is vivified and the social bonds are knit closer, as they always must inevitably be where the facilities of travel are increased and the opportunities of intercourse are multiplied.

Nor is this all. Rapid transit of this nature opens up a number of districts that before were practically inaccessible for residential purposes. There are few of us who care to practice the ancient form of dissipation known as early rising, agreeing rather with Charles Lamb in the idea that to rise with the lark or go to bed with the sheep is a popular fallacy. There are still fewer of us who, even for the sake of rural delights, care to isolate and immure ourselves in remote suburbs reached with difficulty.

In vacation time, it is true, we often seek the loneliness of the woods, or the solitude of the mountain, that we may commune with nature and hear the still, small voice of our better self; but when we are doing the world's work 50 weeks in the year, we want to be handily situated for reaching our desk or bench. If a man lives in the city, he pays a high rent and takes Irish views of the landlord question. If he lives far out, and wastes his time in travel, he is in hearty sympathy with the eight hour movement. I look upon electric roads, therefore, as likely to prove a beneficial agency in the more equal distribution of a happier population around any center, thus increasing the return on outlying property, while, by the encouragement of retail trade, enhancing the profit of the area lying within the region thereafter more legitimately restricted to business occupancy. I have watched with much interest the manner in which electric roads have already thus developed suburban areas. Booms are not a particularly healthy feature of progress, but they may be, and not unfrequently are, genuine and real, and I know nothing more likely to bring on a real estate boom of the best character with permanent results than the installation of a well-managed electric road, enabling a man to leave his work at six o'clock and be sitting down to his supper seven or ten miles out, if he wish, under his own rooftree at 6:30.

Having thus discussed the effects of electric roads on the community and on the individual citizen, I will add a word as to their effect on the wonderful impersonal entity, "capital." If all that I have said be true as to the general benefits, it follows that the wealth and ease of the community are materially increased; but what I refer to now is not the direct enhancement of values, so hard to trace out, though so palpable, but the stimulus given to saving habits by the better opportunities of investment. Careful analysis of the working of electric roads goes to prove that when operated with skill and discretion they are fifty per cent. less expensive to run than horse railroads are. What does this mean? One thing it means is that many roads can be built that would be out of the question with horses. Another is that roads not paying can be placed on a dividend basis.

In 1888 out of nineteen horse roads reporting in New York City, ten showed a deficiency. Last year their net earnings were much better, but it is evident that a horse road is not always a mine of wealth, though it may be of fertilizers. A third point is the establishing of a new class of investments of a solid, enduring nature. It is within everybody's knowledge that the accumulation of capital tends constantly to the reduction of interest to a minimum. There was a time when the long stocking and the iron chest were the common bankers for the savings of the timid; and the capital that was bold earned the double reward of its bravery and scarcity.

As Walter Bagehot, the economist, has remarked, the English people have always wanted to put their money into something safe that will yield 5 per cent.; and this is undoubtedly one reason why English capital, free and fluent, is so much a power in the finance of the world, and why so much comes this way. As Mr. Bagehot says: "In most countries most men are content to forego interest, but in more advanced countries at some times there are more savings seeking investment than there are known investments for." It is thus in America, so far as "safe" investments are concerned, and by safe I mean such as do not require the active care and ceaseless thought of the capitalist, but may be held by trustees, widows, hospitals, universities, savings banks and the like. The competition of capital for the best class of government bonds, municipal bonds, railroad stocks, etc., has reduced the earnings on these to a very low figure, whether in America, or England, or Germany; and the result is that we see to-day, as never before, the planning of enormous trusts and gigantic industrial enterprises, which represent in no small degree the endeavor of capital or savings still to enjoy its wonted income, but in newer fields. Now, I look upon the street railway business of the country, under the regime of electricity, as offering one of the best opportunities for local capital, and for what may be called the organization of local savings, which might otherwise lie around in napkins, like the unjust steward's talent, and be of no use to anybody. The capital in street railways in America to-day reaches from $175,000,000 to $200,000,000.

If the statement I have made as to the superior economy of electrical power be true, how much greater becomes the earning capacity of this investment, how much greater are the attractions held out to construct the hundreds of new roads that are still wanted and will be called for as our towns and cities grow. Of course, I am aware that it may be said that this showing might lead to a demand for lower fares. It might, but the public is intelligent enough to know that other things are more necessary, such as better cars, with better heat and better light, improved tracks, faster running time and shorter headway, so that the fifteen hundred million passengers on the street railroads every year may travel in all safety and comfort. Street railroads are peculiarly suitable as a field for local investment. Their operation can be watched all the time. They run under a man's eye when he is on the street, or past his window when he is home. He knows something of their officials; he can influence the domestic legislation they are subject to; he can assist in more ways than one to swell their earnings.

The next important point to which I would direct your attention is the effect that the electric railway has upon the employes of the service. It cannot be denied that the introduction of electricity in this respect marks a decided advance in the social condition and aptitudes of a large body of men. I have never yet met with anybody or anything that could place the work of a horse car driver in a favorable light. One certainly could not fairly expect a man who spends the day with his nose at the tail of a car horse to realize a very high ideal of life and duty, especially when the whole of the work is done under conditions exhausting alike to temper and physique. It is outdoor exposure the whole time, whether in summer heat or winter blast.

Half the time it is an exercise of sheer brute strength, and no car driver believes in his heart that a horse power is only 33,000 foot pounds a minute. His aching wrists and dislocated shoulders tell him that Watt was far below the mark in putting it at that figure. And then the worry of the street traffic. We have all of us noticed the conscientious persistence with which dray-

men and coachmen will keep on the car tracks in front of a car. An investigation made two or three years ago in Chicago showed that at one point in the streets there, 97·6 of the street traffic sought the railroad, while at another it was 87½, at a third 90 per cent. Against such odds the driver, with his restless or apathetic team, has to make his way and keep to the running schedule; fighting all the time with the fear of an accident either to his car or to some hapless foot passenger.

With an electric car the matter is not one of muscle and brawn, but of average intelligence and ordinary readiness of decision. A better class of men are wanted and forthcoming, or the same men are relieved from physical wear and tear, and thereafter can earn their bread in the sweat of their brow and not that of their body. A woman might easily run an electric car. The motorman gets instantaneously by the turn of a switch the exact degree of power that he wants; he can apply his brakes readily, and if he needs to run backward up hill he can do so sitting down at his switch. It is not necessary to expose him to the weather. His fears as to running people down are materially lessened by the gain in control of the car and by the further fact that an electric car takes up only half the space on the street that a horse car and its team do. The work is not less safe than cleanly. You may remember that when steam roads were started in South Carolina, one of the negro drivers tied down the safety valve and then sat on it. As a result, cotton bales were placed between the locomotive and the coaches to protect the passengers in case of explosion. The new driver was, however, still on the wrong side of the bales. In electric cars both driver and passengers are free from harm. John Bright once said that the safest place on earth was a first class carriage in an express train; but to-day it may be fairly affirmed that no vehicle can compare as to freedom from danger with the electric street car.

A feature of this refinement of the work is that it must necessarily be attended by better pay for the higher intelligence and skill. Mere brute strength does not command good wages nowadays, except in a prize fighter, and the further we get away from animal conditions the better do we find the status of the individual or the occupation to be. The remarks made above as regards the drivers apply equally to the staff at the generating plant. People sometimes wonder why there are so many hostlers around car stables, but when you remember that well kept car horses work only two hours and a quarter daily, you will see that they need a good many attendants at the stables during the other twenty odd hours. In place of these grooms and hostlers you have, with an electric plant, a skilled force of steam engineers and mechanics, each trained for the special function which the principle of the division of labor has shown him to be best qualified for.

And here let me inject the pertinent remark that this new and successful development of electricity is one reason more why the mechanical engineer and steam engineer should master electrical principles and practice whether for the high walks of his profession or for the humbler duties of running a plant. The coming of electricity and its application to light and power have afforded a grand stimulus to steam engineering in every department, and may not improperly be claimed to have created the modern high speed engines. Sir William Thomson has said that the electrical engineer is nine-tenths a mechanical engineer. To this I will add a corollary, and say that the mechanical engineer may be a master in these new electrical fields if he will only add the one-tenth to his education. The time is at hand when the mechanical engineer will not be considered worthy of his name or his calling unless he is also an electrical engineer, as familiar with Ohm's law as he is with Carnot's or Mariotte's.

Incidentally through this paper I have referred to the effect of the electric railroad upon horses. It has, indeed, been most gratifying to see how readily the electric railroad has rallied to the support of the Humane Society. It is a humane society itself. Whether he wished it or not, the electrical engineer in this instance is conferring a great boon on the horse. We sometimes do the greatest good, as we do often the greatest evil, unconsciously, rather than of set purpose; and so here the inventors of the modern electric motor and the electric car have released the horse from one of the most painful and exhausting services that it was ever put to. Investigations over a long period have shown that with the pavement dry a horse would meet with an accident in every 78 miles of travel on granite, in every 168 miles with the pavement damp and every 537 miles with the pavement thoroughly wet. Unfortunately for the horse, though happily for the rest of us, the first two conditions generally prevail on our streets, and hence the horse has a poor outlook as to accidents. But it is not the accident the horse has so much to dread, after all, as the constant strain and the pull of a heavy load from its dead rest every few hundred yards. It is generally admitted by street railway men that car horses fail because of this feature of their work, and that it helps to cut down their railroad life and utility to the average of from three to five years. If you want to see these conditions at their worst, take Broadway, once our pride, now one of the most overrated thoroughfares in Christendom. The pavement is abominable, and the horses, like the foot passengers, can be seen struggling for a grip on the uneven, slippery stones, all the way from one end of it to the other. The traffic on the street is so great that I have noted full cars making a dozen halts and starts from dead rest between Chambers and Barclay streets—two blocks. It does not require an expert to foresee the effect of such wear and tear on animals. In Cincinnati, recently, on installing an electric equipment, a street railway company advertised its horses for sale for family and carriage purposes. I have not observed any such advertisements in New York City. The street railway managers are more modest or more truthful here than they are on the banks of the Ohio. The only persons likely to regret seriously the departure of the street car horses from this city would be horse dealers and feed supply houses, and possibly the street cleaning contractors, though they get their pay, anyhow.

I might point out that, as a further offset to this displacement of a certain amount of labor in an elementary form, whether that of the horse or the human being in charge of him, we have the stimulus given to a higher class of labor, not only in the station engineer and motor car driver, but in the electrical expert and inventor. Society benefits greatly by this, just as it does by the superior skill and efficiency implied in the maintenance of such a system as that of the Pennsylvania Railroad Company. The running of express trains and fast steamships demands the exertion of the best qualities of a man, as well in the conception of ideas of improvement as in the details of solid construction and vigilant management. Here, therefore, we strike at once into a new field of design and invention—one that promises to be as large and fruitful as any other known to the application of electricity. There have already been several hundred patents taken out on the special subject of electric railways, and the whole air is alive with rumors of the ideas and inventions assuming shape. In a year or two it will be a wise motor that knows its own father. Each new step is a prophecy of a dozen more. Each new patent is a "father of its country," a germ of endless fertility. We begin to learn our resources. "Is there any load that water cannot lift?" asked Emerson. "If there be, try steam, or if not that try electricity. Is there any exhausting of these means?"

Now and then I hear the objection that people would be the quicker to adopt electric locomotion if it were not so beset and made costlier by patents. This is not true, and I have no patience with the spirit that begrudges the inventor his reward. Why do we use the great inventions? Simply and solely because they effect an economy for us in some way or other, chiefly in time or money. If they did not, we should care little about them, and the inventive geniuses of the day would be mere common clay to us. But, on the contrary, the inventor is revered and admired, and is encouraged by the wealth and fame he can earn. Occasionally one hears the expression of an idea that the inventor is wanting in public spirit and devotion to science because he takes out patents and does not invite the world to revel in the riches he reveals while he is content to starve over a crust in a garret. A few weeks ago, Mr. Edison told me that he had found one of his greatest intellectual pleasures in reading Evangeline. But why should it be less public spirited for Edison to secure a patent on his phonograph than for Longfellow to obtain a copyright on his poetry? Why should not Bell have a patent on the telephone when Victor Hugo protects his Notre Dame? Is it not as right for George Westinghouse to derive a princely income from his life saving air brake as for Gilbert & Sullivan from their comic operas? Shall not Elihu Thomson enjoy some revenue from his new art of electric welding, as well as Bronson Howard from his Shenandoah? It is time that the ideas on this subject were set in the right perspective. Our inventors enjoy the benefits of the patent system because, like the novelists, the poets, the musicians, and the artists, they are public benefactors. They promote the public welfare, and to the public comfort, increase the public wealth. The field of electric locomotion will be but one more opportunity to demonstrate this truth. There is no patent on the horse, but the patented electric motor can beat him on every point every day in the week.

Such, then, are some of the reflections to which our subject invites us, at this early stage of its development, and there is but one other point to which, after this section, I shall refer in closing. Before I leave the electric street railway, I would again say, as I said at the outset, that I am not presenting this latest application of electricity as perfect. It is not; on the contrary, it is in development and improvement under our very eyes. It is endeavoring to harmonize with its environment. The questions and problems that it opens up are very much like the concentric shells of the Chinese ivory puzzle balls; and we have not yet reached their core. It has one or two family quarrels on hand. The telephone is hardly yet on speaking terms with it. But we know fairly well where the solution of each difficulty lies, and we are on the way to it. Nor am I in any sense an apologist for the shortcomings of our pioneer work. Electric railroad men have made mistakes, are making them now. That cannot be helped. Heaven save us from the men who cannot make mistakes, they will never learn. The conditions in electricity as an industry change with lightning rapidity. A Russian gentleman once remarked of the political situation in Central Asia that it changed every minute; and so it is in regard to the onrush and uplift of electrical discovery and enterprise. This very fact explains why much of the earlier electric railway work has been of an unfinished, unkempt kind. Mr. Charles Francis Adams, some years ago, in his interesting little work on railroads, said: "It is a matter of curious observation that almost uniformly those early railroad builders made grave blunders whenever they tried to do their work peculiarly well, they almost invariably had afterward to undo it." This is not an excuse, however, for slovenly work. It is better to make blunders trying to do well, than in lazily neglecting one's duty, and though it hurts a man who built for eternity to see his work ripped out in five years, he has the serene sustaining consciousness of right effort and honorable performance. The electric street railway will the sooner achieve its social destiny if the engineering done upon it be the highest and best that the art at each instant will allow.

The topic I have reserved for brief final mention is that of electrical long distance travel. This is the department of the subject in which imagination has not yet sobered down into invention. Our fancy still plays around the possibilities, and so far from realizing the social side of teletravel, people have not yet awakened generally to the idea that it has any serious practical side at all. Our patriarchal poet, Whittier, expressed his surprise a month or two ago in his "Burning Driftwood," when he wrote:

"Far more than all I dared to dream,
Unsought before my door I see;
On wings of fire and steeds of steam
The world's great wonders come to me."

The steeds of steam are now an old familiar story, but the mechanical Jay-Eye-Sees of the coming day bid fair to be those with "wings of fire," and then our special speed may be something more nearly approximating that of light. It is amusing, however, to see how quickly our generation has become accustomed to teletravel. Did not the royal college of Bavarian doctors seek to forbid railway travel because it would induce *delirium furiosum* among the passengers, and drive the spectators crazy? Did not an English quarterly say: "We would as soon expect the people of Woolwich to suffer themselves to be fired from one of Congreve's rockets as to trust themselves to the mercy of a machine going at the rate of twelve miles per hour." And did not our own General Webb, in 1835, after a railroad journey with ladies from Boston to Providence, exclaim in horror: "To restore herself to her caste, let a lady move in select company at five miles an hour and take her meals in comfort at a decent inn." Such alarming and conservative extracts have a familiar sound, perhaps, but I can assure you that they are positively of the ancient date mentioned, and not extracts from recent New York newspapers. The fact remains that to-day we have ceased to regard a speed of sixty miles an hour in railway travel as extraordinary, and are casting about for the means with which to attain a higher rate even than seventy-five miles, of which record was made in 1886, on a short run. This acceleration is, it appears probable, to be found best or only in the use of electricity, for the reason that the electric motor may drive directly on the axles, that it need not offer much resistance to the air, or smash the track, and that it does not have to carry its own supply of fuel and water. There are men in this audience who have seen such an electric locomotive making with ease 120 miles an hour, and who propose to propel it at 180 miles an hour. If these things be so—as they are—we know that with electric teletravel the public will have to accustom itself to strange new conditions, exceeding, in scope and power, those of the last fifty years. The change will come in our time, and the present telegraphic and telephonic facilities are but an education for it. When we can talk instantaneously with friends in Boston or Philadelphia over a wire, we resent the inadequacy of the means of fast and far locomotion that should enable us to meet them face to face if we wish to do so. When we see electric cars in our streets traveling easily fifteen and twenty miles an hour, and know that on a clear, unbroken straightaway track we could go from New York to Philadelphia or Boston with the same agency and kindred apparatus in about an hour, American ingenuity and enterprise will not rest until the thing is done. That will be the first stage in the next evolution of travel.

At the present time electric street railroads are running or building in nearly 150 of our towns and cities, with some 2,000 cars on about 1,200 miles of track. So far as urban traffic is concerned, the new departure has been made. Electric locomotion is with us an assured fact, the most civilized form of travel, as the electric light is of illumination and the telegraph or telephone is of communication. Already over 100,000,000 nickel ballots are being cast yearly in its favor, and the welcome to it is universal. In the Northwest that brand new cable plant costing $400,000 has just been thrown aside to make room for it. In the South it is saluted with the exclamation of the delighted darky, "First dey freed de negro, and now dey freed de mule." In New York we are waiting on Providence and the aldermen, but we shall not be satisfied till this city is abreast of other communities in the adoption of that which has given, in so short a time, so many proofs of its ability to promote in every respect the highest social welfare of the citizen.

FLORIDA SPONGES.

J. J. O'DONNEL, in the *Florida Times-Union*, has this to say of the sponge industry of Florida:

One degree from the northern tropic, Key West, an elbow-shaped island, is the only one of a numerous group surrounding it and of the long chain of islands known as the Florida Keys, extending from Cape Florida for a distance of 200 miles (Key Largo and a few others excepted), that is inhabited. Its area is 2,000 acres, 450 of which may be estimated as the area occupied by the city, which has a population 20,000. The number of houses, including factories, stores and residences, of which there are many handsome ones, is about 5,000. The unoccupied part is covered over with shrubbery and underbrush, useless except for firewood. Its geological formation is oolite, which is quarried in small quantities in blocks of 3 × 2 ft. These are used as foundation stones for wooden buildings, though the Catholic convent is built wholly of this stone.

The first settlement in this archipelago of the gulf was made on Key Vaca about the year 1818 by fishermen from Mystic, Conn. In their fishing excursions they found that Key West, from its deep, spacious harbor and easy access, afforded them a better situation. So they abandoned their primitive settlement and roughly constructed homes and betook themselves to Key West, fifty miles farther southwest (the most southerly point of Uncle Sam's dominions), where they erected new homes and plied their vocations under a tropical sun on the verge of the Gulf Stream.

About the year 1826 immigration set in from the Bahama Islands, viz., New Providence or Nassau and other smaller islands. The two classes soon assimilated, as their polemics and vocations were alike. Fishing was the only industry except when some ocean-tossed mariner got wrecked on one of the many reefs or shoals that abound along the western edge of the Gulf Stream between Key West and the Tortugas, seventy-five miles to the westward and also northeast to Cape Florida. These wrecks were numerous, sometimes amounting to as many as two and three a week—forty a year, as shown by the admiralty record in the United States district court. In November, 1859, there were no less than two wrecks on one day, the principal one of which was the Heidelberg, laden with 3,000 bales of cotton, $30,000 in bullion and $10,000 in specie. Between the years 1846 (the year of the great cyclone, which razed every house on the island and scattered to the tempestuous waves Sand Key lighthouse and its occupants) and 1861, when the first gun boomed over the ramparts of Fort Sumter, wrecking was the chief medium of getting money. Even now many an amusing anecdote is related by the first immigrants, and as thrilling as ever warrior told, for sailors, like soldiers, love excitement and adventure, and all the boys and men were at that time sailors; hence little attention was paid to the mine of wealth that lay within sight of their doors, the sponges, the gathering of which has now grown to be one of the principal sources of revenue of the place.

The value of the sponge was at that time well known, for the immigrants from the Bahamas used to go nearly

as far south as Cuba sponging and turtling, so that the sponge could not be said to have been discovered here. The Bahamians were, however, the first to operate the business, and then only when, as they would say, business was dull; which meant that there was not much wrecking. They used to go out among the keys two and four miles in small boats, and in a few hours pick up several hundred pounds of the finest sheep's wool sponges in from eighteen to twenty-four inches of water, and sell them for ten and twelve cents a pound. Even then the business was profitable, as there was little trouble and less expense, owing to the abundance and close proximity of the sponges, though many of the finest used to be lost for want of knowing how to properly cure them.

It was not until 1853 that it could be rated as an industry. In the spring of that year Mr. William Lowe, now a well preserved octogenarian, went as far as Anclote Key, near Tampa, in his schooner, the Chestnut, and returned in a week with a full boat load, which he sold for fifteen cents a pound. Thenceforward and until 1861 there were from a half dozen to a dozen vessels engaged in the business, the prices ranging from fifteen to thirty cents per pound. In the latter year and during the civil war sponging did not progress any, and what little was done was carried on among the adjacent islands. Since that time it has progressed rapidly, until now there are 200 vessels, ranging from four to fifty tons burden, engaged in sponging, giving employment to 1,000 men in Key West alone, and bringing in a revenue of nearly half a million dollars annually.

The only other place in Florida where sponges are sold is Apalachicola, in Franklin county, with a population of 2,000. There are from twenty to thirty vessels

The sponge beds proper extend from Cape Florida to near the mouth of the Apalachicola river, a distance of 900 miles, and from one-half of a mile to twenty miles from the coast, at depths ranging from one to eight fathoms, this being the greatest depth they have yet fished for them. Some are found along the Atlantic coast as far as Jupiter Inlet, though only a few fish in these waters, as they confine themselves mostly to the gulf or bay. The area thus fished in is over 20,000 square miles of water, and there is reason to believe that the sponge can be found at much greater depths and over a large area.

The manner of fishing and the apparatus required are very simple. Each fishing schooner takes from two to six dingeys or small boats; two men go in each boat; one sculls and the other stands at the bow with a sponge hook, which is a three-pronged, sickle-shaped instrument, but more curved and measuring from the point to the base nine inches; the prongs are about one-half an inch in diameter from the base to the curve, and gradually tapering to a blunt point; the haft is round and about six inches long, and driven into a narrow pole one and one-half inches in diameter, and measuring from six to fifty feet in length. The hooks and handles are manufactured here. These contrivances, with an ordinary wooden pail having a glass bottom and designated as a water glass, are the paraphernalia required to catch the sponge. The pail is used only when the weather is cloudy or the water murky or ripples on the surface. It is half submerged in the water, and by looking into it the sponge can be readily seen at a depth of sixty feet. The boat is sculled slowly and stopped only when sponges are seen. There has been no improvement on the methods first

dies, its life depending on the state of the weather—as when it is cold, frosty or blowing a norther the sponge lives for four or five days, even in the tropical climate of Key West. It is next cast into the water. "Crawls," as the receptacles are called, are stakes driven into the water to prevent the sponges from being carried away by the action of the waves. Here they remain for two or three days, after which they are taken out and pounded with a wooden club, and again cast into the crawls. This process of washing out and beating is kept up until all the animal matter is completely removed. They are next strung up in bunches, usually of eight or twelve, according to size, so as to equalize the weight of each bunch, and allowed to dry.

In this condition they are brought to market, where they are sold privately, but in open market, as follows: each bidder puts his price on a tablet with his initials and hands it to the owner, who usually retains the highest and returns the other. Should he, however, refuse to sell to the highest bidder, and the crew demand their money, he pays them accordingly. If sold, the money is divided up as follows: One-half the proceeds goes to the owner of the vessel first, as the vessel's share; the remainder is divided into shares among the captain and the crew, the captain getting a small percentage more than the others. The sponges are then taken to the purchaser's warehouse, where they are trimmed by men, clipping off with an ordinary pair of shears the roots and other loose parts. They are now ready for bleaching, and for this purpose they are dipped in a solution of lime and water, usually about one quart of lime and eight gallons of water, and exposed to the sun for several days, until they are perfectly dry, when they are ready for the merchant.

H. I. M. WILLIAM II., GERMAN EMPEROR.

H. I. M. VICTORIA, GERMAN EMPRESS.

and 300 men employed in this business here, though sponges do not bring as high a price as those sold in Key West, which is due chiefly to the great competition among the buyers in the latter place. The principal buyers are Messrs. A. J. Arapian, John Lowe, Jr., J. Fogarty and W. H. Taylor.

It is also an important industry in the infant but rapidly growing town of St. Marks, in Wakulla county, at the head of Apalachee bay, which is connected by rail with Tallahassee.

Mr. A. J. Arapian is the largest purchaser in the State, as he buys fully two thirds of all the sponges sold in the market, and during the year 1888 shipped from his spacious and well equipped warehouse $277,000 worth of sponges, one third of which was exported directly to England, Germany, and France. New York, however, is the great distributing point, as over three-fourths of the sponge caught is consigned to merchants and brokers there, the principal ones of whom are McKesson & Robbins, Rabaten & Moses, Wood, Heinner & Co., and Lasker & Bernstein. Thence they are shipped to all parts of the world, though they are mostly used in the domestic trade. Within the last ten years the prices have advanced from fifty to seventy-five per cent., which is owing to the great demand for Florida sponge, and the supply being so limited, though there is no appreciable difference in the catch for the past ten years. But, as there are no statistics kept, such information cannot be exactly ascertained. The largest vessel owners are Messrs. John Lowe, Jr., S. S. Lowe, B. W. Albury, H. C. Albury, B. W. Kemp, W. Curry, A. J. Arapian, and F. Wells.

There are also many others who own from one to three vessels. The owners furnish the crew with provisions, and also their families, while they are away on a trip, which usually takes from eight to twelve weeks, depending altogether on the condition of the atmosphere, for in stormy, cloudy, or rainy weather the water becomes too rough and murky to fish.

adopted, as above described, for catching the sponge, though Mr. A. J. Arapian in 1883 tried the diving system, and brought over for that purpose four Mediterranean divers, and after large expenditure had to abandon the scheme for the following reasons:

First—The heavy iron shoes of the divers trampled the young sponges so much that they would not grow.

Second—The whole sponge was taken up, so that none would again grow there; while, if taken up with the hook, there was always enough left to grow again.

Third—It was impracticable on account of the rocky bottom.

There was at that time a Turkish law prohibiting any diving for sponge whatever, and last year the Florida legislature passed the following law, viz.: "An act to protect the sponge fisheries on the coast of Florida and to punish the gathering or catching of sponges by diving, either with or without diving suits or armor. Chapter 3,913, laws of Florida. Approved Mar. 8, 1889." When it is considered that hundreds of fishermen are day after day employed throughout the whole year, and that the number is constantly increasing, as well as the fact that the same ground has been fished over thousands of times and millions of dollars' worth of sponges have been taken out, the conclusion is that the supply is still inexhaustible. Though along the keys between Key West and Cape Florida there are but few of the fine sheep's wool sponges which used to be found in abundance when the industry was in its infancy, still some of the sponges taken in the neighborhood of Rock Island measure six feet in circumference and fifteen inches high. Such sponges are, however, rarely found, and sell for prices ranging from $100 to $150 for exhibition purposes, as they are practically useless for anything else.

After the sponge is taken out of the water it is cast on the deck of the vessel or upon the beach, exposed to the sun for twenty-four or forty-eight hours until it

The bleaching here of late years is nearly altogether dispensed with, and the sponges are now mostly shipped unbleached in bales of any size from ten to five hundred pounds. The bale presses consist of four posts and a floor in which holes are bored in order to regulate the size of the bales. In making a small bale, posts are stuck in the holes and boards stretched inside, making a square box. A canvas is laid on the floor of the box and the sponges thrown into it. Overhead and fixed to the ceiling is a hydraulic jack, by means of which the sponges are pressed and firmly packed. When the bale is of the required size, the posts and boards are removed, and the canvas is placed around sponges and tightly roped, while the jack still presses the bale. When the bale is thus roped, the jack is loosened and all pressure taken off. The bale is taken from the press properly tied and prepared for shipment.

There are many varieties of sponges, viz., the sheep's wool, the yellow, the grass sponge, the velvet, and the glove sponge, all differing in quality and price, the sheep's wool being the highest priced and selling in the market at Key West at $2 and $2.25 per pound. The others sell from 75 cents to $1.50 per pound.

Of those employed in fishing, more than half are colored; scarcely any Cubans follow the business for a livelihood, as they nearly all stick to cigar making. This is due to the fact that they cannot stand the cold and fatigue which are necessarily attached to sponging.

THE EMPEROR AND EMPRESS OF GERMANY.

As all the world is now so intently watching the moves (perhaps we might write it *moods*, for to the uninitiated the latter seem to govern the former) of the young Emperor of Germany, we think our readers may be interested in the accompanying portraits of him and the Empress, for which we are indebted to the *Graphic*.

Although so much has already been written about

these illustrious personages, we venture to state a few facts in regard to their lives.

Frederick William Victor Albert, now known as William II., was born January 27, 1859, in Berlin, and until he was fourteen years old his education was entrusted to Dr. Hintzpeter, assisted by Major Von Gottberg, who was military instructor. At this time his corps of teachers was increased by the addition of Prediger Persius, who prepared him for his confirmation, which took place September 1, 1874, at Potsdam. As William was to lead an active life, it was thought best to send him to the gymnasium at Kassel.

Orders were given that he and his younger brother Henry, who accompanied him, should receive the same treatment as the other pupils, and this order was strictly obeyed. He graduated from this school January 24, 1877, just before his eighteenth birthday. After this his military career began with his entrance as an officer into the 1st Garderegiment at Potsdam, that he might become thoroughly acquainted with practical service. The young prince was assigned to the company which his father had once commanded. After serving here for a short time he went to the University at Bonn, and from there went back to the army again. In 1880 he was betrothed to Augusta Victoria, Princess of Schleswig-Holstein, and on February 9, 1881, they were married. The Empress is about a year younger than the Emperor, and makes an excellent mother to her four little sons, to whom she is devoted. Their oldest child, little Prince William, the present Crown Prince, was born at Potsdam, May 6, 1882. His father's devotion to the army will doubtless prompt him to make a soldier of his son at an early age; in fact, he wore the uniform of a fusilier of the guard before he was six years old.

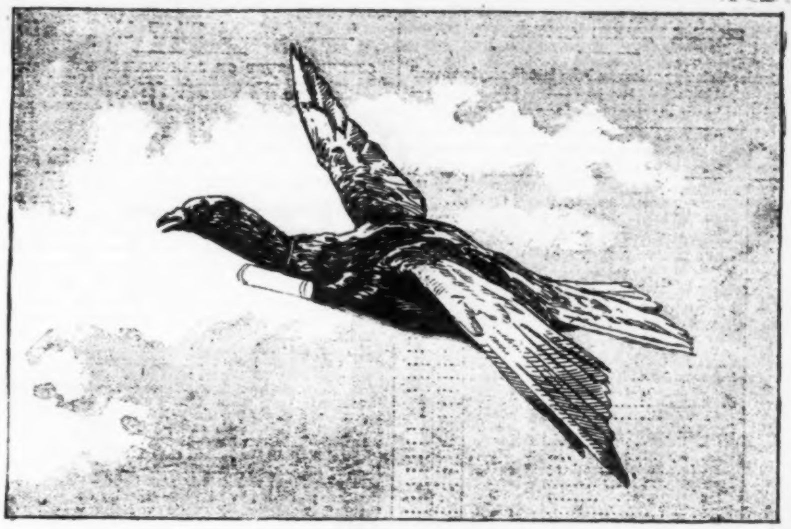
Emperor William ascended the throne in June, 1888, upon the death of his father, Frederick III.

THE OXFORD AND CAMBRIDGE BOAT RACE.

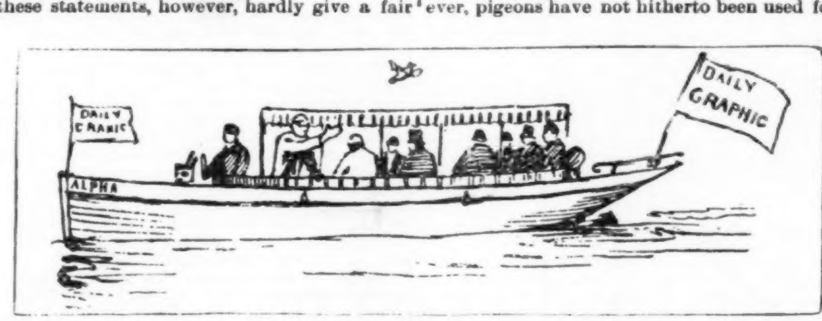
IN the long list of boat races between Oxford and Cambridge, that of March 26, 1890, will in the future hold a very prominent place. A grander struggle has seldom been witnessed. Indeed, if we except the dead heat of the year 1877, the equally sensational race of 1886, when the Cambridge crew went through Barnes Bridge a length and a quarter to the bad and yet won, and the contest of 1867, when Oxford won by only half a length, it may claim to be the finest of the last thirty years. At no part of the race was there more than half a length of daylight between the two boats, and in the end Oxford won by barely a length.

Even these statements, however, hardly give a fair idea of the intense excitement which marked the race from start to finish, for the fortunes of the day varied in a very striking fashion. Except in one particular, the surroundings could not possibly have been more favorable, the afternoon being gloriously fine, with scarcely a cloud or a suggestion of rain. The one disadvantage was a rather high wind, which made it clear to those who knew the river that the crews would have some very rough water to get through before reaching the end of their journey.

The fact of the race being fixed to start at such a convenient time as half past four made it certain that the attendance would be an enormous one, but it is no exaggeration to say that the actual numbers exceeded all expectations, it being the opinion of many who had watched the race for years that the crowd was the largest ever seen. The race took place on the Thames from Putney to Mortlake, the usual course. We give a sketch of the start from the London *Daily Graphic*, and other sketches of the pigeon post.



THE CARRIER PIGEON.



THE OXFORD AND CAMBRIDGE BOAT RACE—CARRIER PIGEONS SET OFF FROM "THE DAILY GRAPHIC" ELECTRIC LAUNCH.

THE PIGEON AS A CARRIER.

FOR a long time past this aerial messenger has been regularly employed in the service of the evening newspapers of the Midlands and North of England in carrying reports of football matches and other events from outlying districts. So far as we are aware, however, pigeons have not hitherto been used for the conveyance of sketches intended for publication. In order to insure the rapid delivery of the sketches made by our artists at the boat race, we had pigeons specially trained for the purpose of carrying the sketches from the course to our offices, where they were received by another staff of artists, and prepared for publication in the *Daily Graphic*. The birds were loosed from the *Daily Graphic* launch and the press boat both during the actual race and at the moment the crews passed the winning post.

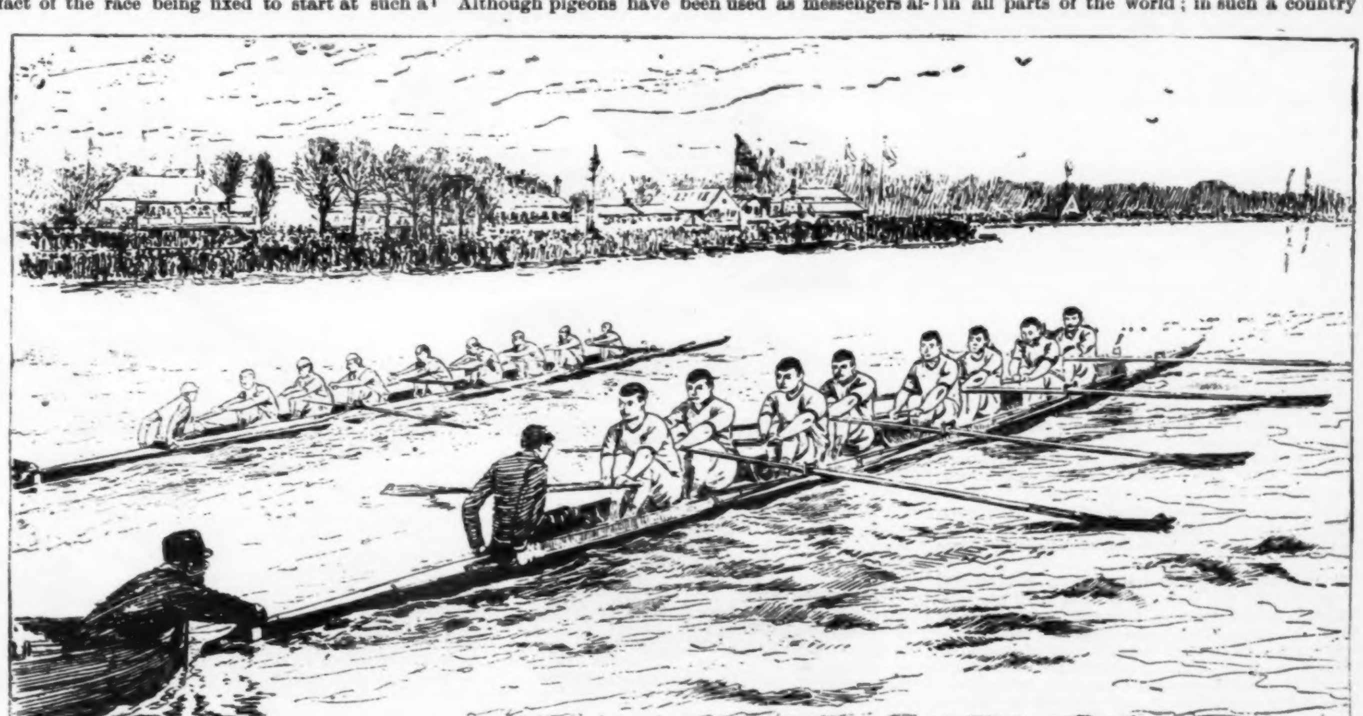
Although pigeons have been used as messengers almost from time immemorial, it appears to be only in a few instances that they have been so utilized as a regular means of correspondence, where there was no emergency. The ancients, when they took a long journey, and were desirous of sending back any news with uncommon expedition, were accustomed to take tame pigeons with them. When they thought proper to write to one of their friends, they let one of these birds loose, with letters fastened to its neck, and it would never cease its flight till it reached its nest and young ones. Taurothenes announced to his father his victory at the Olympic games by sending to him a pigeon stained with purple. Hirtius and Brutus corresponded by means of pigeons at the siege of Modena. In modern times the most noted were the pigeons of Aleppo, which served as couriers at Alexandretta and Bagdad.

Thirty-two pigeons sent from Antwerp on one occasion were liberated from London at seven o'clock in the morning, and on the same day at noon one of them had arrived at Antwerp; a quarter of an hour afterward a second arrived, and the remainder on the following day.

During the siege of Paris carrier pigeons were extensively used, and the breeding and training of them for military purposes are carried on in connection with the German army.

As carriers of telegrams these birds can be easily and inexpensively used between country houses and post offices situated some miles apart. The birds require to be bred upon the spot to which they are intended to fly, and then to be sent away from home and kept in an outhouse or stable, where they cannot see the surrounding country. When liberated, they at once fly home, and can carry telegrams, letters, etc., rolled up and tied around their necks, weighing up to two ounces (a lighter weight is, of course, better), at the rate of a mile in two minutes, and they are seldom, if ever, lost. When a reply to a telegram is expected from the post office situated some miles distant, a pigeon can readily be sent into the post office by the rural postman at very small expense, to await the arrival of the telegram at the post office, when it can be dispatched with the telegram tied around its neck, and will arrive home in a few minutes, with a saving of many shillings in porterage, and much more expedition.

The Imperial British East Africa Company are sending out to East Africa each month a number of carrier pigeons, to be bred and trained there to carry messages between their different stations inland and on the coast. Homing pigeons are hardy, and readily breed in all parts of the world; in such a country as East

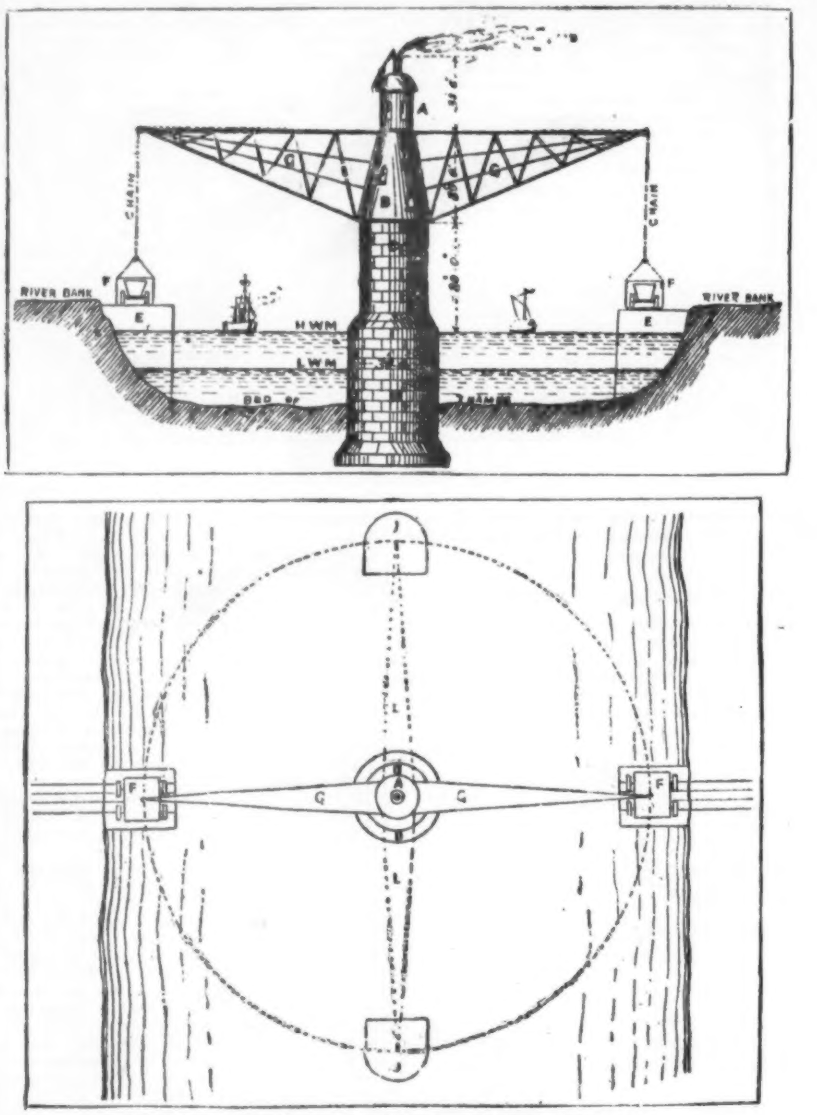


THE RECENT OXFORD AND CAMBRIDGE BOAT RACE ON THE THAMES—THE START.

Africa a proportion of them are likely to fall a prey to hawks and other rapacious birds, but they are sure to be very useful to the company.

A FERRY DERRICK.

IN view of the recent controversy with regard to the respective merits of "Tunnels and Ferries" as a means of transporting goods and passengers across the Thames below bridges, a suggestion which possesses attributes of neither may not be amiss. A correspondent of the London *Daily Graphic* sends a sketch of what may, perhaps, be characterized as a crude idea, a huge steam derrick, with two arms, and revolving in conjunction with a tower on a circular granite base in the middle of the river. The arms would of course be long enough to extend to either bank, and the loads carried across would be attached to the arms by chains which could be raised or lowered. If the idea has nothing else to recommend it, at least it would be cheaper than either bridge or tunnel.



STEAM PASSENGER DERRICK FOR THE THAMES.

METALLIC RAILWAY TIES.

THE railway, as now constituted, with its wooden ties 8 feet in length, supporting rails that often have a medium spacing of 3½ feet, requires a length of wood much greater than the metallic part, and for this reason necessitates, both for the construction and keeping in repair, a large consumption of wood. Many attempts have been made to replace wood by metallic supports. Aside from the saving in wood, there would be here a capital interest for metallurgy, since in the supplying of ties or sleepers it would again find that outlet that it closed to itself by the invention of steel rails, which in a manner require no replacing, for they do not wear out, while old iron rails have to return to the foundry every ten or fifteen years, in order to be converted into new ones.

Unfortunately, it is difficult to find a type of tie that satisfactorily answers all the conditions imposed. It is especially in foreign countries—Holland, Belgium, and Germany—that experiments with all-metal railway tracks have been made, and also in hot countries, such as Algeria, where the use of metallic ties is a necessity, on account of the too rapid decay of wood.

In France, a few isolated experiments have been made by the railway companies, but it does not look as if the use of metallic ties is to enter into practice very soon.

However this may be, a few specimens of all-metal tracks were shown at the exposition, and we have thought that it would prove of interest to give a few details as to the most widely used types.

As the type of a rail upon longitudinal sleepers we represent in Fig. 1 that of MacDonnell, which is a transformation of the Barlow rail. This type of rail was laid in 1853 upon a section of the Bristol & Exeter Railway, and is still in service. As Mr. Cantagrel remarks, in a study upon all-metal tracks, this is the most lengthy experiment that can be cited. It is very remarkable that this track should be still passable, and capable of satisfying conditions of traffic that were unknown in 1853.

The MacDonnell track is formed of a wide sleeper. with a rib, and upon which rests a U-shaped rail through the intermedium of wood. Bolts traversing these three parts hold them firmly together.

The evident advantage of the track with longitudinal sleepers is that the rail is supported throughout its whole length, shocks at the joints are avoided, and a smoother rolling is secured. There should consequently result a certain saving in the total weight of the permanent material and in the cost of keeping the track and rolling stock in repair; but it was soon found in practice that these advantages were more apparent than real, for it always happens that the ballast forming the support is distributed too irregularly under the sleeper, and the rail is no longer held in a continuous manner. This necessitates the selection of types almost as resistent and consequently almost as heavy as in the track with ties. Besides, it is necessary to secure a rigid intertying of the parallel lines of rails, and to maintain them on curves with the desired inclination in order to prevent derailments, which otherwise would be almost inevitable, for the rails always tend to spread, and, on the passage of trains, there result zigzag motions that are more trying and dangerous than the shocks at the joints of rails upon ties. Finally, it must be added that the roadbed must be kept in a perfect state of repair, or else water will remain under the track, and, displacing the ballast, destroy the regularity of the ramming. This may necessitate a large amount of work, and we find an example of it in the installation adopted upon the Alsace-Lorraine lines, which are provided with the Hartwich rail. Each line of rails is supported upon a line of stones, and the latter are traversed every 15 feet by a drain that debouches into a longitudinal ditch.

In Fig. 3 we reproduce an engraving (taken from Mr. Cantagrel's communication) representing the type of track with metallic sleeper, applied in England upon the Great Eastern Railway. This sleeper, which is known by the name of its inventor, Mr. James Livesey, is stamped out of steel plate, and directly supports the rail, the foot of which is held on one side by a riveted bolt and on the other by a wooden wedge that enters a jaw fixed beneath by the rivet. This type of track, however, is almost entirely abandoned in Europe, but, by reason of the diminution in the weight of metal that attends it, it is always used in the Indies upon lines whose traffic is not very large as a general thing.

Tracks with longitudinal sleepers or the Livesey sleeper are now the exception upon railways, and ordinary tracks with ties form, so to speak, the sole case to be considered.

It is for these, therefore, that it is expedient to seek a type of tie capable of replacing the wooden tie. Numerous tentatives have been made in this direction, and the principal types tried were shown at the exposition.

Despite these tentatives, there are few of these types that it is possible at present to judge of definitely, for the test of them has not extended over a sufficient number of years. It is necessary, in fact, that a metallic tie shall last at least thirty years and require an almost insignificant amount of repair in order that the use of it shall prove advantageous, for it must be heavy and therefore dear in order to give the track stability. On another hand, with the processes of wood preservation, such as creosoting, now employed, we have succeeded in much prolonging the duration of wooden ties, and Mr. Clerc, superintendent of the Company of the West, estimates that at the end of twenty-five years wooden ties thus prepared, which have undergone no deterioration as the result of accidental mechanical stresses, will still be in a good state of preservation.

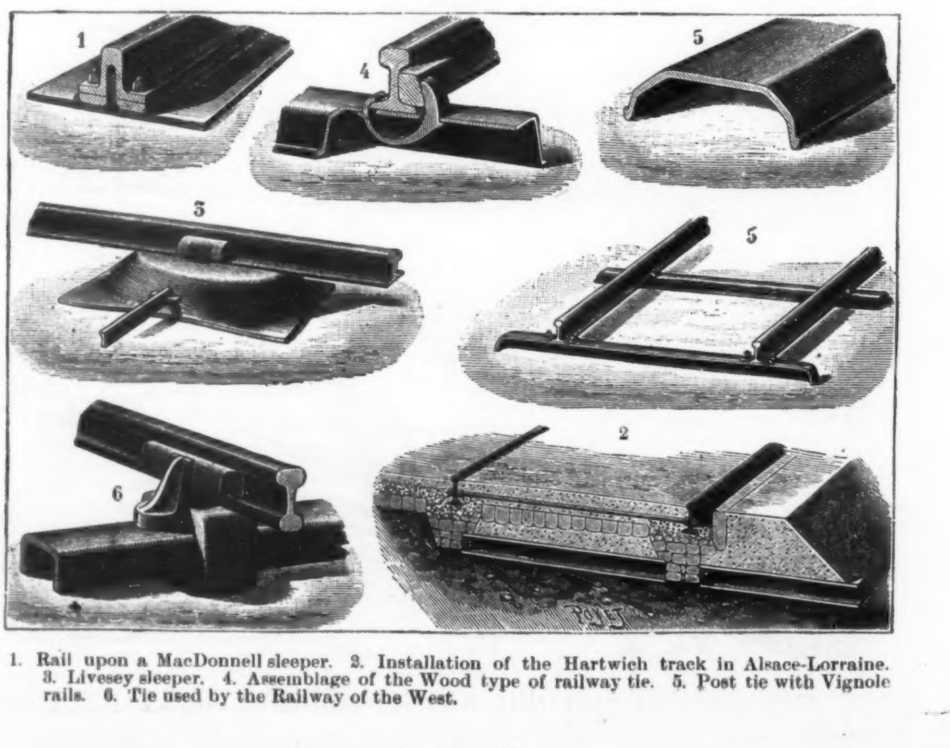
The main trouble with metallic ties is that it is difficult to keep the ballast rammed down and to obtain assemblages that are always firm. It happens, in fact, that fastenings wholly of metal obtain a play in a short time and become loose, and the rails, being no longer sustained, get out of place, do not permit of a smooth rolling, and undergo greater wear.

Most of the types of metallic ties tried are derived from the Vautherin tie. They are formed of an inverted U-iron whose extremities are so bent as to constitute upon the roadbed a sort of bottomless box which holds the accumulated ballast.

In Fig. 5 we represent the Post tie, which is extensively used, and with success, upon the Netherlands lines, and we figure at the same time an application upon a Vignole track. This tie presents a longitudinal profile of variable thickness obtained directly in the rolling mill, and this permits of giving the rail at its base of support an inclination of $\frac{1}{20}$ without there being any need of bending the tie, for this operation has the inconvenience of facilitating the escape of the ballast.

The state railways of France, which a few years ago made a trial of metallic ties, have adopted this arrangement after a comparative study by Mr. Bricka. This tie, moreover, is adapted to the I or double-headed rail and for relieving the assemblages.

The cast iron chair is provided with an appendage that engages in an aperture in the tie. The tie weighs 127 lb. and is 8 ft. in length and 6 in. width at the base. The rail is held by a wedge made of a bent steel plate forming a spring.



1. Rail upon a MacDonnell sleeper. 2. Installation of the Hartwich track in Alsace-Lorraine. 3. Livesey sleeper. 4. Assemblage of the Wood type of railway tie. 5. Post tie with Vignole rails. 6. Tie used by the Railway of the West.

As an arrangement of the Vautherian tie in which the assemblages are suppressed, we may instance the Wood type (Fig. 4), where the rail is fixed upon the tie by means of a horseshoe shaped piece of steel with the interposition of a piece of wood. Another and more curious type is that of the Company of the West, which has no assemblages at all. The tie shown in Fig. 6 is of steel and is U-shaped. It is 8 inches wide and 8 ft. in length. At the point that is to receive the rail there is cast an iron chair that encircles the entire section of the tie for a length of four inches. These chairs are firmly fixed as a consequence of the shrinkage that they undergo upon cooling, and, in order to prevent any longitudinal movement, apertures are formed in the tie through which the molten metal may flow. The arrangement represented is designed for double-headed rails, but it may be applied also to the Vignole rail.

A large number of other interesting types of ties were met with at the exposition, but we cannot describe all of them here, and shall merely mention a few of them. The Severac tie, for example, is formed of a simple I iron, to the foot of which is riveted a bow of flat iron three times its width. This iron is turned up at the extremities of the tie, and thus opposes a resistance to lateral displacements. The Bernard tie is formed of two U-irons parallel with each other and connected by a plate of iron that serves as a base. The Somzee tie is formed of a sort of continuous flooring of corrugated iron plate upon which the rail rests through the intermedium of a bar of flat iron, which gives it the necessary inclination. The Lambert tie, U-shaped, with central rib, is fixed to the rail by two simple clamps, without bolts. In the Moncharmont device, the double-headed rail is held upon its chair by a key having an eye that gives passage to the assembling bolt.—*La Nature.*

THE SIMS-EDISON MOBILE TORPEDO.

When the new gun factory for the War Department at Watervliet, N. Y., shall have received and put up its plant for actual work, a date which optimistic official calculations speculate upon as about the end of the present twelvemonth, the entire capacity of the U. S. government arsenal for the production of heavy cannon for coast defense, for the protection of the great and wealthy cities of the Atlantic and Pacific seaboards, will amount to ten 8 in., six 10 in., and four 12 in. guns per annum. The country became anxious concerning its defensive capabilities in 1883, and in 1886 the Fortification Board made its report to Congress, in which the number of guns reasonably requisite to protect the approaches to the city of New York was estimated in caliber and number as follows:

Eighteen 16 in., two 14 in., forty 12 in., twenty 10 in., fifteen 8 in. cannon, in addition to one hundred and forty-four 12 in. mortars; and the total armament for existing and proposed fortresses along our Eastern and Western coasts to 581 guns of all calibers, besides over 700 mortars.

Four years have passed, and, with the exception of one 8 in. gun, of the built-up steel type, which has been experimented with at Sandy Hook, and another 8 in. and a 10 in. in course of completion, and as many mortars, we have no heavy ordnance for defensive uses other than the Rodman cast iron smooth bores of thirty years ago, Parrot rifles of "doubtful strength," and a small number of 8 in. converted rifles.

This condition of our coast armament is certainly far from reassuring to such as gravely consider the possibilities of the time and situation, and it does not afford much relief to be told that, if we had the guns of the first year's production ready for use, it will require some months to prepare the emplacements for their reception.

Manifestly, there is no practical use in blaming the legislative or executive departments at Washington for a national condition which is really due to twenty years of popular inertness and over-confidence. It has been well said that the military and naval officers and the inventors and scientists of no nation are more impressed by the necessity of modern and adequate provisions for defense of its coasts than are those of the United States. Congress has made liberal appropriations, and the bureaus have expedited the work of production as rapidly as could be expected with types of ordnance entirely new to the resources of our public and private industries, requiring not only new plants of machinery, but standards of metal before uncalled for. The general policy governing our legislation has decided that in our exigency we must not buy cannon abroad; but, even if such a course were accepted as a *dernier ressort,* with the present demands upon them from Europe and the far East, the greatest workshops of England and the Continent would not be able to execute our orders.

In this very natural situation of a country suddenly forced to recognize the "innocuous desuetude" of its defenses, it has been some satisfaction to dwell upon the fact that the marine torpedo is an engine of American origin, and that the system of channel fixed or floating torpedoes, which has been perfected by the U. S. Engineer School of Application, at Willets Point, is said to be regarded by the foreign officers who have been able to acquaint themselves with its details, in any considerable degree, as the most reliable and effective protection for the approaches to seaboard cities possessed by any power in the world. For some years—since 1869-71, in fact—Congress has appropriated considerable sums for the development of the system, rarely less than $50,000 for each of the ten more recent sessions, and during the 50th Congress attaining a total of $500,000, until under the expert direction of General Abbot and his successor Col. King, commanding the School of Application, the scientific and mechanical features have been permanently formulated, and a provision of material made for the more immediate and conspicuous needs of the country.

When Mr. Tilden, with impressive and prophetic eloquence of expression, urged upon people and legislators an instant and sturdy policy of coast defense as the essential question of the hour, there were not a few who, while listening respectfully to his argument, gave less consideration to its force than they would have done had they not accustomed themselves to believe the fixed and floating mine defenses of the two approaches to New York, by the Narrows and the East River, adequate protection against the entrance of hostile vessels. This is overweening confidence, based upon defective intelligence; no men would more coolly and summarily dissipate its optimistic dream of security than the experts who have planned and carried out the fixed mine system of channel defenses. The greatest authority upon this subject is Gen. Abbot, and he has distinctly stated that the fixed mine, though a very important one, is but a single feature of a thoroughly well designed and effective theory; we quote from his lecture in November, 1887, before the Naval College:

The elements of first-class system for coast defense, as already stated, are: (1) High power guns and mortars for keeping the armored ships of the enemy at a distance; (2) land fortifications to hold the position; (3) obstructions in the channels of approach; (4) flanking guns, movable torpedoes, and the electric light to cover the obstructions; (5) vidette and torpedo boats to watch the enemy and make offensive returns. These elements are of primary importance, and they are the only elements which can be so regarded; their relative importance at different sites will vary, but according to modern engineering principles no site is thoroughly defended unless all of them are represented.

These elements hardly admit of intercomparison as to relative importance. Each must be sufficiently elaborate to fulfill its special function at the locality. Thus obstruction cannot replace high power guns; neither can high power guns replace flanking guns; nor can any or all of them replace fortifications or vidette and torpedo boats, which are essential to guard against surprise and to make the offensive returns which are so necessary to any defense in war. When these five elements are judiciously combined and sufficiently developed, they may be trusted to do their work without further assistance, provided the site is favorable.

Of these several elements of a first-class system we unfortunately lack No. 1, the high power guns of long range, and the prospect of their production within several years, in such number as to adequately arm all the channel defenses of the seaboard, is not encouraging; No. 2, our land fortifications, we have, it is true, but they are not modern erections, and would offer but a brief resistance to long range ordnance projecting enormous bolts from a distance our smooth bores cannot cover; No. 5, vidette boats and torpedo boats, we have but one or two of, and this feature does not seem to find favor with the naval authorities or the government. But we have the channel obstructions in the system of fixed mines, while the flanking guns, etc., are accessories of easy and rapid production, and, moreover, of much smaller relative cost to the country than the heavy cannon of the new type and the fleets of dispatch craft referred to.

In his contribution as chairman of the committee upon "Torpedoes, Stationary and Movable," to the report of the Board on Fortifications, transmitted to Congress January 23, 1886, General Abbot refers to the moral effect of fixed mine systems, when the knowledge of their existence is possessed by the enemy, as follows:

"The knowledge that the harbors of the North Sea and the Baltic were defended by mines deterred the French fleet from approaching any of them during the late Franco-Prussian war; and the same protection proved sufficient for the Russian harbors in the Black Sea in the late Russo-Turkish war. Some important object is needed to induce an attack on any harbor known to be obstructed by mines, and places of little importance do not offer sufficient inducements to an enemy to risk the loss of his vessels. Hence, with our great ports properly defended, the rest of our coast can be cheaply protected by mines and old forts."

General Abbot wrote the above in 1885, before the science of using counter explosives to destroy beds of fixed mines had attainted its ultimate development. In 1887 he suggested the danger of counter-mining, and in the same paragraph the usefulness of movable torpedoes to anticipate the approach of counter-mining vessels. We quote this paragraph and a following one, which indicates with admirable distinctness the essential qualities of a movable torpedo for coast and channel defense, from the lecture previously referred to; and in doing this we have no thought of disparaging the usefulness and importance of the fixed mine system, which, in our opinion, is generally a valuable and, in particular situations, an indispensable feature of harbor protection:

"In the absence of an effective fire of artillery, and particularly where special vessels shall have been constructed for counter-mining (such as the dynamite vessel recently constructed by our navy), movable torpedoes controlled from the shore can be made to play an important part. Unless the currents are strong there is no urgent need of very high speed, say above ten miles an hour.

"The most valuable points from an engineer standpoint are: (1) Invulnerability to fire, whether of machine guns, of rapid-firing guns, or of cannon throwing grape and canister; (2) capacity to carry three or four hundred pounds of the explosive; (3) a range of at least two miles; (4) the power of diving under any simple boom protection, such as a ship could easily improvise from her spare stores. The ordinary service conditions, such as being under perfect control, presenting a small target, etc., of course are essential. All these conditions can be fulfilled in practice, and I entertain no doubt that such boats will form an important but subordinate element in every perfect system of coast defense."

The Sims-Edison torpedo, of which we present an illustration, in vertical section, in cut No. 2, is "a movable torpedo controlled from the shore"—that is to say, which is not only steered, but likewise receives its propulsion from the shore.

TRIAL OF SIMS-EDISON ELECTRIC TORPEDO, AT WILLETS POINT, N. Y., JULY, 1889. MAXIMUM SPEED, 19·2 MILES.—(From instantaneous photograph.)

The inventor, Mr. W. Scott Sims, commenced his experiments about 1875, and has continued them up to the present time, having at last attained a practical working perfection which probably more nearly realizes Gen. Abbot's suggestion of the desired engine than any other one of the several mobile torpedoes that have been subjected to official test. The Sims-Edison is a horizontal structure of two parallel parts, the lower, a cylindrical body with very sharp conoidal ends and having a length of from 16 to 18 diameters, being the torpedo, and the upper a float from which the torpedo is suspended, at a submergement of six feet, by light but very strong steel stanchions. The float is boat shaped, with a well rounded hull amidships to assure equilibrium and buoyancy, and a sharp, clean entrance forward and delicate lines sternwise. It is decked over hermetically, and when filled with cotton or some buoyant ballast designed to render it unsinkable, should its skin be penetrated by bolts from rapid firing or machine guns, has a displacement graduated to keep it a little more than a-wash. Upon the deck of the float, fore and aft, are two upright staffs, tipped by balls for steering purposes, secured to the deck skin by spring hinges, so that, should the progress of the torpedo encounter a log or wreckage floating on the surface, they will bend backward before the obstacle and allow the float to pass under it, regaining their perpendicular when the normal situation is again secured. This capacity of the boat to clear itself from obstacles in its way by going beneath them is also first assured by the oblique shaping of the fore stanchion frame, which possesses a knife edge sharp enough to cut through such weak hindrances as nets or cordage. Other mobile torpedoes explode on contact with anything in their way, thus endangering peaceful or friendly boats, but the Sims-Edison has no liability of this nature, being controlled entirely from the shore.

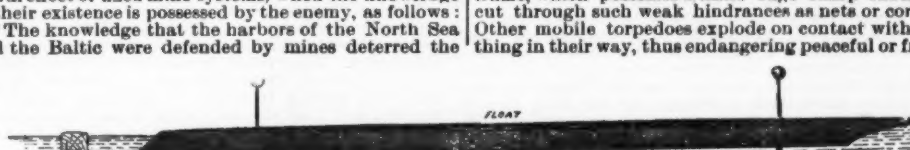


FIG. 2.

The material of the torpedo and its float is copper sheeting of a thickness sufficient to assure strength and stiffness. It weighs, all told, from 3,000 to 4,000 pounds, the motor (40 horse power) weighing 764, and 6,000 feet of coiled cable 600 pounds.

As indicated by the cut, the torpedo is divided longitudinally into four sections (whose contents are shown by the lettering), which, after being taken apart, can be again assembled in fifteen minutes, rendering carriage on deck or in the hold not difficult.

Of course, as the motive and controlling agent of this torpedo is electricity, the cable is a particularly important essential. The one now in use is the invention, after careful experimenting necessitated by the unsatisfactory performance of imported cables, of Mr. Sims. It is manufactured for his exclusive use at the great shops of the Edison Company in Schenectady. To afford the reader a thorough technical statement of the electrical details of the invention, we quote the subjoined description from an expert article in the *Electrical Review,* an authority of recognized correctness and weight in the special science which it represents:

The cable is compound, having a small insulated con-

ductor in the center for the steering current produced by a battery on shore, and an annular conductor for the motor current. This cable has an unusually high insulation, having repeatedly been subjected to a tension of 24,000 volts without damage, the tests being verified at the time by a Thomson electrostatic voltmeter. The main insulation is in five superposed layers. Even one of these layers by itself was not pierced at 12,000 volts. Probably the insulation would stand a higher tension than 24,000 volts. Resistance of 6,000 ft. of cable, six ohms. It is interesting to note that this splendid cable is made in this country. Imported cables heretofore used have invariably failed in keeping qualities.

The motor and generator are both of Edison make. The motor is two pole, series wound, and its resistance at rest is 6·53 ohms. The generator is an Edison "Municipal," 1,500 to 1,600 revolutions, 1,300 volts at terminals and 25 amperes normal capacity. The motor at full speed absorbs about 1,150 volts, which at 25 amperes of current develops mechanically about 33 horse power available for propulsion. Some sacrifice of efficiency of transmission has had to be made to keep the weights at a minimum. The cable, having six ohms resistance, absorbs 3,750 watts and the motor about 4,000, a total loss of nearly 8,000 watts—say 10 horse power—in overcoming resistances.

Notwithstanding this, however, the motor on the official trial drove the boat at a speed of over 21 miles per hour, and on short runs reached 22 miles per hour. When we consider that this means a speed of over 30 ft. per second, we can realize how difficult it would be for an enemy's guns to be effectively fired at the boat. The float is a "one mile" boat, is 30 ft. long by 24 in. beam, while the boat or fish is 30 ft. long by 20 in. diameter. Such an object at full speed is almost impossible to hit, and even if hit no worse damage can happen than a slight decrease in the buoyant power of the float. The torpedo proper is invulnerable, because inaccessible under the water.

Steering is effected by a powerful electro-magnet, into which is switched the main current by means of a strong polarized relay actuated by the current of the shore battery through the central conductor of the cable. Two keys, or one pole-changing key and switch, under the hand of the officer on shore, control the relay in the fish, and the rudder is thus thrown to one side or the other at will, at any moment. The result is that while at full speed the boat may have its course changed in any desired direction at any moment. Every conceivable evolution can thus be performed, and the boat far more skillfully and intelligently maneuvered than if a pilot were aboard directing its moments from a position which would necessarily be low down and command but a limited range of vision.

Spars and other debris are no obstacle. On the official trials the boat has dived under them and been guided onwardly as if nothing had opposed its course.

The charge is exploded electrically, and hence there is no probability of premature discharge. The moment the boat has reached and is pushing against the hull of the enemy can be exactly determined day or night by a simple ammeter in the circuit, showing by its great change of reading when the motor is affected by the stoppage of the boat. The *tout ensemble* of the Sims-Edison torpedo is of the simplest possible character. The best of material is used in every detail. The admirable arrangement and principles of operation of the various electrical devices render it practically certain that each of them may be fully relied on to do its duty at all times.

The first Sims-Edison torpedo belonging to the U. S. Engineer Corps was purchased by Gen. Abbot, Jan. 9, 1883, less than ten years ago. We doubt if any similar invention has been so rigidly and specially tested. It has been subjected to more than a hundred trials with a view to discovering its defects and suggesting improvements, and is still ready for service. Among the tests conducted by Gen. Abbot was one to determine the indestructibility of the float under fire. It was fired at five times at a range of 370 yards, and eight times at a range of 186 yards, double-shotted canister charges, each containing 96 balls, from a 32 pound howitzer. Five large holes were the result, but the float was after all perfectly serviceable for an attack. Another time the power of the float to resist or endure concussion was tried and demonstrated by driving it at 9·1 miles per hour against an anchored spar, the float in both instances diving under the obstacle and continuing its course. As a consequence of such continued and satisfactory experiments, nine additional two mile torpedoes have been purchased by the War Department. The present form of torpedo can without difficulty be made to attain a speed of 25 miles per hour, and with a range of four miles if the targets on the deck of the float clearly indicate the course to be steered.

The large cut, reduced from a photograph of a trial conducted by Colonel King at Willets Point, shows the float going at a rate from 18 to 20 miles per hour. The peculiar waves produced—notably the butterfly wings sheets of water thrown up by the bow—are interesting suggestions of the speed of the torpedo, which in its course has got in advance of the wave.

Should an unlooked for exigency necessitate carrying out to the maximum of present possibility the defense of the harbor approaches, it is reassuring to know that torpedoes of the type above described can, with no longer interval of time than is necessary to arrange and place contracts, be furnished in any number required. Constructions of the improved size and proportion would be 32 feet long by 2 feet diameter, carrying 500 pounds of Prof. Emmens' high explosive and furnished with motor capacity up to a speed of 25 miles. Theoretically the Sims-Edison possesses a combination of energy in doing its work and immunity from chance in attaining its ends that no other offensive engine of its class has claimed, and there is abundant proof that its practical effectiveness has already been established by the varied and rigid tests to which it has been subjected.—*Army and Navy Jour.*

SPEED OF BIRDS.—The vulture is credited with a speed of 150 miles per hour; the wild goose and swallow, 90 miles per hour; the crow 25 miles per hour. Carrier pigeons are credited with 600 miles in 8 hours, and 3 miles in 3 minutes and 24 seconds. Recent trials give about 1,100 yards per minute for carrier pigeons.

THE PEPPERMINT INDUSTRY OF ST. JOSEPH COUNTY, MICHIGAN.

A DRIVE through the pleasant roads of St. Joseph County in the fall of the year is an experience one recalls with pleasant recollections. If you happen to go south from Kalamazoo at the time when the annual crop of celery is being shipped, you will catch a glimpse of the greatest celery-producing section in this country, if not the world. When you reach Three Rivers, the principal town of St. Joseph County, your sense of smell alone will help you to locate yourself. You walk up the street to the post office, and the first thing you notice will be the odor of peppermint; you run against a farmer, and it is sure to bring forth peppermint; you go into a drug store, and you declare they keep nothing but peppermint in stock. Every fifth man you meet has a peculiar shaped tin can under his arm which he guards most tenderly, and you see the same style and size can being loaded into farmers' wagons, and your inquiry brings forth the fact that they are peppermint cans.

Driving through the country, you find field after field of peppermint that has recently been cropped, and every mile or so you see a still house in operation or a pile of peppermint straw to indicate recent operations. If you happen to be with a peppermint man, he will size up the straw pile and tell you how much oil that still produced. We all know of the peculiar property of peppermint to open the air passages, and even if the dust is so thick as to make you stop for a new duster, you seem to forget the dust as you fill your lungs with St. Joseph oxygen flavored with peppermint.

Next to Wayne County, New York, St. Joseph County in Michigan is the largest peppermint-producing locality in the United States. As early as 1846 farmers began to cultivate the plant in this locality, and the industry has continued to grow ever since. Almost every farmer thereabout raises some peppermint, but usually in connection with other crops, while a few devote their whole time to its cultivation. By far the principal grower is Mr. Henry Hall, of Three Rivers, and "Hall's Big Marsh of Florence" is the largest piece of land in America devoted to raising peppermint. The farm is eight miles southeast of Three Rivers, and contains some 900 acres, of which 400 acres are put into mint each year and alternated with clover to keep up the strength of the soil. Mr. Hall has four large distilleries with total capacity of some five hundred pounds of oil daily; the largest still house is situated in the center of a 600 acre field. It contains four stills and is surrounded with mint fields as far as the eye can see.

The cultivation of the plant is accompanied with more than ordinary care and the success of the crop depends largely upon the attention it receives, as well as the season. The ground is plowed in August, September, or October, then thoroughly harrowed, and the following spring it must be harrowed again, then marked and planted. Old roots from "first" crop are removed from the ground in spring, and planted in rows three feet apart. A man carries the roots in a sack on his back, throws them into the rows, and they are then "kicked in."

Two or three crops are gathered from each planting, the first and second crops are the best, and twenty pounds of oil to the acre is a good yield; the third crop is very apt to be "weedy," and the yield only about ten pounds to the acre.

From the time the mint appears above the ground until it is gathered, it should be constantly cultivated and hoed to keep it free from weeds, which are the bane of the peppermint grower's existence. The plants mature from the middle of August to the first of September, soon as the blossom is out; the "second" crop mint comes first, then the "first" crop, and lastly the "third." It is cut with a mower and by hand with a scythe, and if weedy the weeds must be sorted out by hand. The plant stools out and spreads, but "first" crop is in quite distinct rows, the second year it grows from the runners which fill in the rows, making it a more solid mass, and in the "third crop" this is still more apparent.

After cutting, the mint is allowed to partly dry or "cure," and is then racked into cots like hay and drawn to the still house, where it is immediately distilled.

The process of distillation is not complicated, but interesting. The still is a large wooden tub with tight hinged top, a steam supply connection at the bottom and outlet to the condenser at the top of one side. The condenser used by Mr. Hall is a very effective and unique piece of apparatus; the worm instead of being in a coil is in longitudinal sections about 14 ft. long, which lap under each other, the top about 6 in. in diameter and tapering to some 2 in. at the bottom or outlet, and is made of tin. The cooler consists of a tin trough about 8 in. in diameter with perforated bottom, the length of the condenser, over which it sets and through the perforations a constant stream of water is kept flowing over the tin condensers.

The mint is drawn to the still house in wagons, pitched into the still, the packer "packs the tub," the top is fastened down and the steam turned on for about an hour or until exhausted; this is told by pulling out a plug in the top of the still. Across the inside bottom of the still is a frame with chain connections that run to the top; by means of a heavy crane which is connected to these chains, the exhausted mint or "charge" is lifted out of the still and carried away on a wagon. The "mint straw," as it is called, is dried in the sun and used as fodder for sheep and cattle.

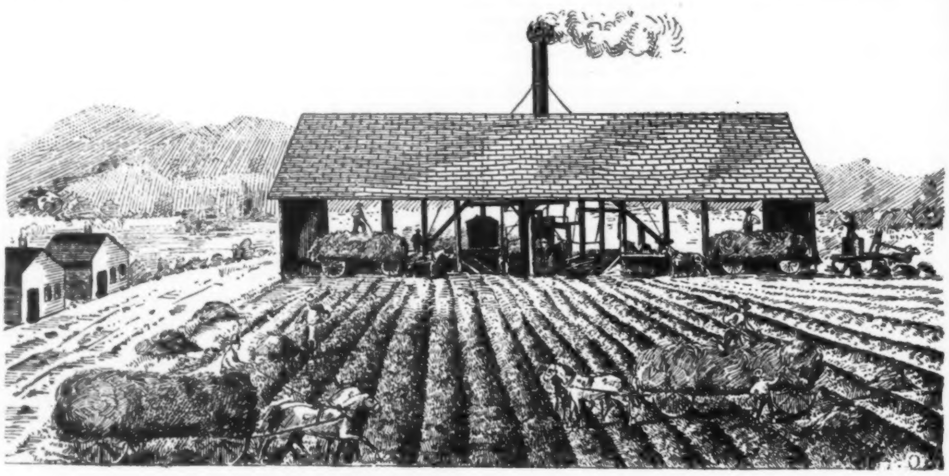
The quality of the oil produced depends entirely on the mint used and the freedom from admixtures of "weeds" or other foreign substances.

Careless and lazy farmers raise poor mint as well as poor wheat, and whether it be "first," "second," or "third" crop mint, thorough cultivation is an important consideration in producing good oil of peppermint. Everything that comes from a still is by no means pure oil, and experience is a most important factor in judging of its quality.

Enough has been written about tests for oil of peppermint to fill a large volume, but one of experience in the business will judge of the quality of a can of oil almost as soon as he places his nose to the opening. It may be necessary to examine it for water or castor oil and alcohol, and possibly other adulterants, or to see that none of the menthol has been removed, but the natural *flavor* of pure oil of peppermint is what the man of experience first seeks.

The annual output of oil of peppermint from St. Joseph County is sixty to seventy thousand pounds, and as the integrity of the party from whom one buys is the first consideration, the following information about the principal dealers in that locality will be of interest to all large buyers.

Mr. Henry Hall, of Three Rivers, is the largest grower and distiller of peppermint in the county, and besides his own product he buys largely of smaller growers. He began buying and raising some oil as early as 1868, and to cultivate it largely in 1882. He handles some other oils besides peppermint, but the latter largely predominates. He makes a specialty of the redistilled or purified product, is thoroughly responsible, and an acknowledged authority; and every confidence can be placed in what he says about an oil.



THE PEPPERMINT INDUSTRY OF ST. JOSEPH COUNTY, MICHIGAN.

Mr. H. D. Cushman, of Three Rivers, is another responsible dealer. He has been in the business since 1872, at first did some raising, but has practically discontinued that branch of the business. He was educated at the Michigan University and has made a special study of testing and examining essential oils. He at first adopted the apparatus of D. Wolf for redistilling the oil and has since designed and constructed improvements of the process to more perfectly retain the natural flavor of the oil, and makes a specialty of his brand of redistilled oil peppermint. His menthol inhaler, so well known to all druggists, consumes a large share of his attention. In the inhaler he employs the Japanese menthol, because it has a higher melting point and larger crystals.

Mr. A. M. Todd, of Nottawa, has done much to spread the reputation of St. Joseph Oil. He is a distiller and refiner and makes a specialty of redistilled essential oils. His "Crystal White" brand is well known in the drug trade. He began to refine oils in 1877. In 1889 he started the manufacture of pip-menthol, but did not find it profitable in competition with the Japanese product. Mr. Todd has written several articles on the subject of essential oils, which have appeared in our standard literature.

Mr. A. P. Emery, of Mendon, has been in the business since 1860, and is the important dealer in his township. He has cultivated as high as one hundred and ten acres of peppermint yearly, and handles the product of his neighbors very largely. He deals only in the natural oil, of which he is one of the largest dealers in Michigan, and sells principally to wholesale dealers in the United States and Canada.

Mr. George Keech, of Centerville, is another of the large wholesale dealers and has been established since 1863. His business has steadily increased, and he is classed by the New York jobbers as one of the solid men of his section in that enterprise.

No reflection is intended by the omission of the names of other doubtless responsible dealers of oil of peppermint in St. Joseph Co. Mention is made of only the largest dealers of recognized responsibility in that locality, and is intended purely for the information of those firms who have or may desire to have dealings with reputable dealers, and who cannot visit the locality in person, as was the pleasure of the writer. In a business where so much depends upon the commercial integrity and experience of the dealer, one likes to know something of him with whom he deals.

The soil of St. Joseph County seems to be well adapted for raising good peppermint. The business is being carried on there with increasing volume and prestige, and the care which is being exercised in the cultivation of the plant assures the quality of the oil produced. At one time if a package of oil of peppermint was not labeled from "Wayne Co., New York," it was thought to be inferior. That day is past. St. Joseph, Mich., is producing as good oil as any other locality, and wherever known its value is recognized.—*The Pharmaceutical Era.*

BAYLAC'S SLOW BURNING STOVE.

SLOW burning stoves have been in discredit since the discussion to which they gave rise at the Academy of Medicine; yet it would be wrong to look at only the bad side of them, for such a system of heating really has its advantages. The stove is cheap, easily kept in order, is accompanied with no danger of fire, and gives a mild and nearly uniform heat.

The great drawback to these stoves is that the carbonic acid engendered in the fireplace comes into contact with incandescent coal before reaching the chimney, and this converts it into oxide of carbon, a very poisonous gas. This trouble is further aggravated by the slight draught that the gases escaping at a low temperature are capable of bringing about in the chimney. So the oxide of carbon, too, often escapes into the room and threatens the lives of those who occupy the latter.

Instead of purely and simply giving up the use of movable stoves, the best thing to do is to try to diminish the dangers of them, either by an intelligent observation of the conditions under which the heating takes place or by means of fitting improvements in the construction of the grate. It is in the latter order of ideas that an attempt has been made to solve the problem. Mr. John Baylac, among others, has devised an interesting arrangement, which figured at the Universal Exposition, but at too late a date to be submitted to the appreciation of the jury. To have a visible and continuous fire burning at a white heat with a disengagement of flames, and to reserve half of the stove for the efficacious utilization of the heat and the rational circulation of the gases, were the problems that the inventor set himself to solve.

FIG. 2. FIG. 1. FIG. 3.

FIG. 1.—SLOW BURNING STOVE. FIGS. 2 AND 3.—VERTICAL SECTIONS.

The accompanying figures give a perspective view and two sections of his stove. The gases, instead of traversing a mass of burning fuel, flow freely to the chimney after circulating around the jacket of the stove.

The coal receptacle tapers downward so as to facilitate the descent of the fuel. It is placed eccentrically in the cast iron jacket of the stove, and is suspended from the upper disk of the latter. A movable bottom with a sand joint closes this coal receptacle, and the whole is surmounted with an ordinary cover.

The fireplace is formed of a sort of box open in front and united with the wide base of the coal receptacle or hopper. From the bottom of this latter starts also a kind of concave screen of refractory material, which reflects the heat upon the fireplace and forms a sort of combustion chamber in which the gases burn. The latter are consequently obliged to follow the route shown by the arrows, so as to effect a transmission of the heat to the room under proper conditions, while at the same time but slightly heating the back of the hopper.

The grate has a surface equal to a third of the section of the stove. Sixteen inches beneath, there is an aperture for the entrance of the air necessary to keep up the combustion. The width of this is at least one-fifth of the surface of the grate.

There is no damper in the pipe, whose section is a quarter of that of the grate. In order to modify the combustion, Mr. Baylac increases the admission of the air instead of reducing it, and to this effect he opens the sliding doors in front to a greater or less degree.

The arrangements of this stove permit of lighting it with ease, of removing the residues of combustion, of letting it go out every night and relighting it every morning without removing the coal from the hopper. The latter should never reach a high enough temperature to produce disengagements of gas through the under cover. This stove, if not driven, is capable of burning 18 hours without a renewal of the charge.—*Revue Industrielle.*

THE EMPLOYMENT OF CRESOTINIC (OR CRESOTIC) ACID.*

By J. HAUFF.

THERE is hardly any branch of industry which in proportion to the simplicity of the labor produces such varied *final* results as tanning.

Although dependent upon local and outside circumstances, tanners have the difficult task of combining public taste with the real use which the article serves, and at the same time of maintaining a standard product.

When it became possible by the advance of chemistry to ascertain the influence of water, tanning materials, and lime, upon the manufactured article, the necessity of finding methods and means to reduce the effects of uncertain conditions was felt all the stronger.

The aim of scientific research to predict and regulate effect from cause has lately borne good fruit to the tanning branch of industry; and it is now only a question of time for chemistry with its boundless resources to prescribe the means whereby to obtain a uniform product independent of all outside factors.

The two chief sections of work in tanning—

First, the preparation of hides for tanning;

Second, the actual tanning process;

are equally important in their bearing upon the quality of the finished product.

The preparation of the hides is again subject to two divisions:

(*a.*) The unhairing process.

(*b.*) The cleaning process.

It is the last mentioned with which we have to deal more particularly, and that which has reference to the *new process* for "*freeing skins from lime by cresotinic acid*" as now manufactured.

Every tanner doubtless knows that the hides, in the unhairing process with *lime*, absorb a large portion of it—up to 3 per cent. of its weight in the dry state. The lime remains partly on the outside, fills the pores and apertures of the grain, and enters partly into a kind of chemical combination with the substance of the hide itself.

Experience has shown that lime is to a certain extent a necessity for many kinds of leather, but there are a great many sorts where the presence of lime even in small quantities is positively injurious, preventing the production of certain qualities; so that the regulation of the amount of lime in the hides must be considered as one of the principal operations in the cleaning process.

But it is not alone the amount of lime in itself which influences the tanning and the quality of the finished leather; it is even more the amount of lime combined with the substance of the hides, which affects the softness, suppleness, elasticity, and greater or lesser density.

The operation which follows the mechanical cleaning of the hide by means of a polishing stone or scud iron, and which removes the lime and makes it fit for tanning, is called "bating."

The process of "bating," that is "unliming," always entails a change in the aggregate condition of the hide, so to speak, and it is therefore the chief aim of the tanner to keep within the desired limits. To this must be added the process of removing the fat in the hide, which has nearly always been carried out by the mechanical means following the operation of "bating."

The "bate" has the same object in the tanning industry—as bearing on the specific qualities of the leather—as the mordants have in the dyeing and printing industries; and it is owing to the recognition of their importance that so much attention is being given to their development.

It is assumed that the purpose of the "bating" and its effects are known. I have therefore only to dwell upon the advantages and the application of the new method of removing the lime by means of cresotinic acid.

Cresotinic or cresotic acid belongs to the number of the so-called aromatic carbon acids which are derived from the cresols of the coal tar methylphenols in the same way as the salicylic acid is derived from the carbolic acid.

* From the Journal of the Society of Chemical Industry.

By cresotinic acid is understood the isomeric carboxylic acids, obtainable by the action of carbonic acid upon the sodium compounds of the cresol-isomers. The union of cresotinic acid with lime gives a salt of the following formula:

$$C_6H_3(CH_3)<\begin{matrix}O\\CO.O\end{matrix}>Ca$$

There are several isomeric cresotinic acids, and all of them have this same power of removing lime.

Being produced from nearly the same raw materials, cresotinic acid, although consisting of several isomers, has, nevertheles, a decided character of its own. The manufacture of it has attained a high state of perfection, and it is now salable at a price which offers no impediment to its use in tanneries.

Cresotinic acid has the same antiseptic qualities as salicylic acid—in fact, in a much higher degree; its use excludes therefore all the dangers so disastrous with other "bates."

Its solubility in water is very low. It requires 800 to 1,000 parts of water, and consequently it avoids any formation of skin-destroying concentrated solutions.

A hide or skin may be immersed in a concentrated solution of cresotinic acid, containing 22 gallons of water and about 4½ oz. of cresotinic acid, for weeks, without showing the slightest trace of decomposition or destruction, whereas other acids which have been used for the same purpose, such as sulphuric, muriatic, acetic, lactic, and butyric acids, etc., in the same degree of concentration, were seen to destroy the skins in a few days, nay even in a few hours.

The reason is that cresotinic acid possesses besides its faintly acid properties certain tanning or hide-preserving functions.

It has, moreover, by its action upon the hide substance known to tanners as "hide gelatin," the great power of bringing the hides down and softening them quite as much as the "bating" with "dungs."

By reason of its great affinity for lime, and by the formation of crystalline combinations effecting osmotic changes in the interior of the hides, cresotinic acid forms easily soluble basic lime salts which remove the lime very quickly, often within a few hours.

Cresotinic acid thus combines the power of removing lime and softening the hides, saving the tanners (by its subtile influence upon the hides and on the solution of "glue-forming" substances which are not precipitated by tannin) unnecessary loss of weight and damage to the hides through decomposition.

Cresotinic acid, as an acid, has, moreover, the power of swelling the hides. For this reason it has great value in the plumping of sole leather, and the hide-preserving and antiseptic properties are here of the greatest importance.

To "bate" with free cresotinic acid, the same vat or pit that has served the purpose hitherto may be employed (one with a revolving paddle wheel is preferable). It should contain water to the extent of about double the total weight of the hides, not more.

For instance: To 50 heavy "butts" of about 56 lb. each, about 450 to 550 galls. of water are used. To every 250 galls. of water 7 lb. to 9 lb. of cresotinic acid are then taken. To 500 galls. of water about 18 lb. of the cresotinic acid would be taken, previously made in a small vessel into a paste, with about 7 galls. of hot water, until no lumps large enough to resist solution remain (or steam can be turned on to hasten solution).

This solution is then gradually and equally added to the vat or pit with active stirring. This "bating" liquor will then be found acid.

If it does *not* redden litmus paper, the cresotinic acid has been neutralized by the presence of free lime which the vessel contained from previous "bates." This circumstance necessitates the addition of more cresotinic acid until the desired acid reaction is observable.

The hides or skins ready for "bating" are then put in, and it may here be remarked that with this new method, no alteration is necessary in the preparation of the hides for "bating" beyond a little more attention to the removal of the "ground" hairs, because these would become somewhat fixed again by the astringent properties of cresotinic acid.

For economy's sake it is also of importance to free the hide from lime in the usual way by the ordinary mechanical means as much as possible, before commencing the "bating" process proper.

Generally speaking, the work to be done beforehand is the same with the cresotinic as with all other methods, but this can be materially reduced at the expense of the quantity of cresotinic acid used, and of the duration of the process.

This is, however, a question which every tanner will solve for himself.

The hides or skins now remain in the "bating" liquor, which is kept at a temperature of 80° to 85° F. until they are sufficiently smooth or "brought down," the liquor being meanwhile frequently stirred or "plunged"—that is, wherever there is no paddle wheel to keep the whole agitated.

The length of the process depends partly on the thickness of the hides and partly on the condition in which they have been put in. In most cases four to six hours, or even less, will suffice. During the whole time, the hides should be watched until the point is reached when they are sufficiently brought down.

The work to be done after "bating" is the same as by the old process. In most tanneries the hides are cleaned with the polishing stone, and "scud iron" immediately afterward. Some tanners put them through the "stocks" and wash them with clean tepid water. Others put them immediately after the "bating" into the tan liquor. There the experience of the tanner will decide which course is best to take.

The "bating" liquor is by no means exhausted with the first batch of hides. On the contrary, several more may be put in; but the water wasted should be replaced by turning on steam or by adding hot water along with dissolved cresotinic acid in proportion to its volume (1 : 300) and the temperature should be again brought up to 80°–85° F.

It is desirable to avoid the loss of "bating" liquor as much as possible. Experience has shown that with such a "bating" liquor, *i. e.*, 500 galls. water to 18 lb. of cresotinic acid, four lots of 50 hides each can be bated, which at the present price of 1s. 6d. per lb. amounts to 1½d. per hide.

For every further lot of 50 heavy hides, only 4 lb. to

5 lb. of cresotinic acid need be added, and the liquor may be used until it becomes unfit, by accumulation of dirt, etc. It may here be stated that in a well known tannery, many thousand hides have been treated in the same liquor, after being refreshened each time without the action of the liquor being weakened or rendered useless by putrefaction (as would be the case with dung liquors).

If the hides are required to be brought down exceptionally low and smooth in the grain, then the following method has been shown by experience to be capable of replacing advantageously the dog dung "bate:"

Instead of taking free cresotinic acid, its combination with ammonia is taken, and another ammonia salt is added (either chloride of ammonium or sulphate of ammonia); all the other manipulations—the proportion of water to the weight of the skins, the mechanical work before and after the bating—remain the same.

Only the ingredients of the "bating" liquor are different, as the following examples will show.

With 500 *sheep* skins for glove leather, each skin weighing about 2 lb., 225 galls. of water are taken, and 11 lb. of cresotinate of ammonia. This the tanner can easily make himself, by adding gradually to his solution 11 lb. cresotinic acid, prepared in the before mentioned manner with hot water, a watery solution of ammonia (spirits of hartshorn), and stirring it until the cresotinic acid is dissolved, but taking care that the reaction still be acid.

With a solution of 20 per cent. ammonia, only about a gallon of it is required to 11 lb. of cresotinic acid. This solution, as well as a solution of 11 lb. sulphate of ammonia or of chloride of ammonia, is mixed with the 225 galls. of water brought up to 80°—85° F., the skins are then put in a vat with a paddle-wheel and revolved for about half an hour, so as to be in every way fit for tanning. Close observation is here also necessary to determine the duration of the bating. The skins are treated afterward according to requirements. Those destined for glove leather are put into clean tepid water, "scudded," smoothed, and freed from hairs. Should there be any difficulty about the latter, which however seldom happens, sulphide of sodium in the proportion of 1 : 1,000 is added to the tepid water, by which the hairs are completely removed.

This "bating" liquor, after being revivified each time with hot water or steam, as described, but *without* adding cresotinic acid, can also be used as long as it has any effect; which, by the way, means about eight lots of 500 skins each, and *then only* about 3 lb. of cresotinic acid with the corresponding quantity of solution of ammonia and 1 to 2 lb. of chloride or sulphate of ammonia is added for every further lot of skins.

For other kinds of skins the proportions are the same.

By this method the "scudding" and working of the skins after the "bating" should not be omitted, because by it the skins are freed from all dirt and fat. Whether it is also necessary to put them through the "stocks" must be left to the choice of each individual tanner.

These methods for "bating" are a complete substitute for the so-called "stink" or "dung" processes in tanning.

The practical results fully bear out the theoretical considerations of their superiority, as is shown by the samples of leather which are here.

It deserves to be mentioned in conclusion that the weight obtained per hide is quite in accordance with the peculiarity of cresotinic acid, which *preserves* the substance of the hide *instead of destroying it.*

THE HUANCHACA MINING COMPANY, BOLIVIA.

THE Huanchaca Company, with a capital of 6,000,000 Bolivian dollars, divided in 6,000 shares of $1,000 each, was organized at Valparaiso in 1873. The object of the company was to work the mining concessions of Pulacayo, Ubina, and Asiento, situated at a short distance from Huanchaca, in the province of Potosi (Bolivia). These concessions cover an area of 2,300 acres, as follows:

	Acres.
Pulacayo	1,186
Asiento	875
Ubina	239
Total	2,300

The company own at present, besides these mining rights:

a. Two large metallurgical establishments, one at Huanchaca (hence the name given to the company), and the other at Asiento.

b. A railway connecting Huanchaca with the port of Antofagasta on the Pacific coast, a distance of 397½ miles, which was entirely constructed with the company's means and credit.

c. A telegraph line of 621 miles connecting Huanchaca with Sucre, Potosi, and Antofagasta.

d. Finally, numerous buildings, comprising dwelling houses, workshops, depots, churches, hospitals, hotels, and schools.

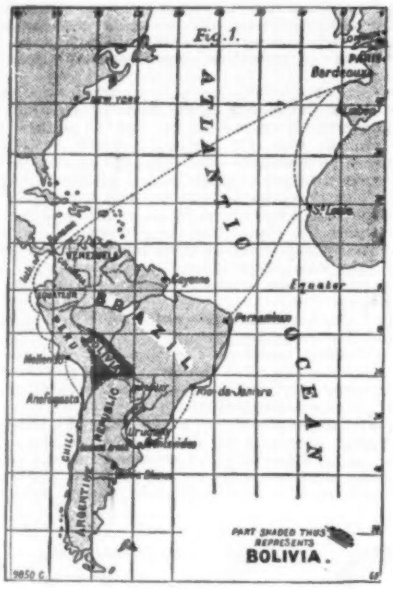
The Pulacayo lode was worked in the time of the Spanish dominion, but had to be abandoned during the last century in consequence of an Indian revolt headed by Tupac Amaru, who gave himself out to be a descendant of the Peruvian Incas.

Shortly after this event the Spaniards had to leave the South American republics to their own devices. The mines were forgotten and remained abandoned for many years, and it was only in 1830 that prospectors are said to have got as far as Huanchaca. The value of the ore encouraged parties to make various attempts, from 1830 to 1873, to grapple with the enormous difficulties in the way. The climate resulting from the immense elevation of the mines, the distance and total want of means of communication with the coast, and finally the refractory nature of the minerals encountered, contributed one and all toward ruining and discouraging a series of local syndicates. The present company was then formed in 1873, and taking a wide view of the problem, decided to remove the greatest difficulty by constructing a railway to the coast.

This was a gigantic work for a mining company to undertake, considering that the distance is nearly 400 miles, and the height to be attained at Huanchaca above the level of the sea no less than 13,498 feet.

From 1877 a period of prosperity commenced that has continued without interruption to the present time. During the eleven years from 1877 to 1888, the output of these mines attained the value of 50,000,000 of Bolivian dollars, the net profit amounting to $20,000,000, of which $17,000,000 were distributed to the Huanchaca shareholders.

A glance at the maps on the present page will show the position of the mines and the extent of the railway.



Huanchaca is on the extreme border of the Potosi province, near the highest ridge of the Andes, at west longitude 69° (Paris meridian), and 20° 26' south latitude.

Easy communication with the Pacific coast is insured by means of the railway line to Antofagasta. Mule pathways and inferior cart roads connect the mines with the principal towns of the Bolivian republic.

The central ridge of the Andes in the neighborhood of Huanchaca attains a height of 14,960 feet above the level of the sea, whereas the rails, at the entrance of the San Leon tunnel, leading to the Pulacayo underground works, are, as mentioned above, at 13,498 feet above the sea level. The village of Huanchaca is situated at 6¾ miles to the north of Pulacayo.

The climate is cold and tolerably healthy, with, of course, the drawbacks inherent to so great an elevation. The rain falls very heavily during the summer months. The soil is quite sterile, and in consequence the general appearance of the country is extremely arid.

The formation at Pulacayo appears to be composed of a ridge of hard and compact trachyte, accompanied on either side by a zone of soft and decomposed rock of the same nature, where the metalliferous lodes are found; and again on the outer sides of this decomposed trachyte, extensive beds of compact argillaceous conglomerate cover the mountain sides with a thick red coating named by the local miners "chocolate."

The great Pulacayo tunnel, 10,745 feet in length, cuts the mountain from side to side, affording a complete section of the formation, as shown in Fig. 3. The extent of each formation as cut through by the tunnel is drawn to scale; but the dotted lines, indicating the surface outline of the ridge, are imaginary, and are simply given to illustrate the perfect symmetry of the formation.

From the orifice of the tunnel at X to a distance of 3,280 feet, the conglomerates are uninterrupted, commencing with reddish and well-cemented clay pudding rocks, abounding in rolled bowlders of divers dimensions, but at 900 ft. to 1,000 ft. from the entrance it is more compact, contains fewer bowlders, and is highly feldspathic. These are followed by 100 ft. of the same rock, where white feldspar spots become more and more abundant.

Between 3,380 ft. and 3,487 ft., counted from the extremity, X, a first coating of decomposed and whitish trachyte is met with, containing several lodes. From 3,478 ft. to 4,406 ft., the trachyte formation gets harder and at the same time greener in shade. Here also several lodes are encountered, and among others the "veta pacamayo," which has been explored, and is now worked by the company.

From 4,406 ft. to 5,200 ft. the trachyte is of a lighter shade, is more compact, and contains fewer fissures. Here three lodes are found close together and form what is termed the "veta nueva." The hard and compact trachyte rock proper, corresponding to the central ridge, is met with between 5,200 ft. and 6,744 ft. This rock contains fine crystals of orthose feldspar, crystalline quartz, and at times crystals of hornblende. Its color is alternately of a grayish white and greenish shade. In this portion only three fissures were found, as well as a dike of conglomerate from which arsenical vapors escaped when it was intersected by the tunnel.

Beyond this central or backbone rock the same series is encountered; from 6,744 ft. to 8,265 ft. the formation is similar to that found in the neighborhood of Pacamayo.

From 8,265 ft. to 10,233 ft. the trachytes are decomposed as on the opposite side, and contain two large lodes known as "El Tajo" and "Santa Rosa," as well as a number of feeders supposed to run into these two lodes.

From 10,233 ft. to 10,745 ft., where the tunnel runs out to surface again, the conglomerate termed "chocolate" is again met with, identical in every way to that found on the other side of the ridge.

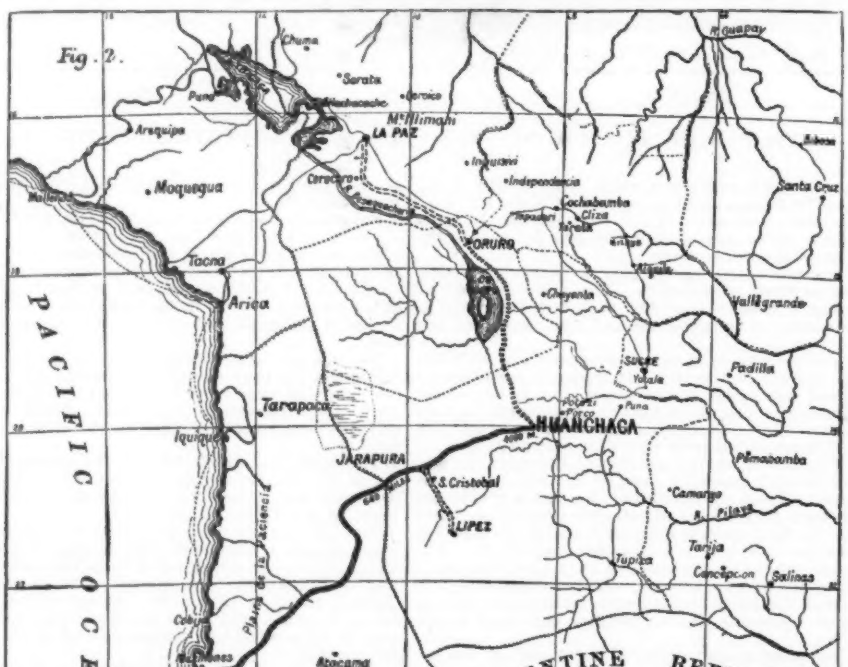
We have thus a complete section of the trachyte upheaval, which appears to have broken through an andesite rock containing black mica found to the east as well as to the west of the tunnel. Beyond this irruptive rock of older date to that of the trachytes, silurian metamorphic slates are found in upright positions.

The principal minerals contained in the lodes of Pulacayo are:

Blende, galena, iron and copper pyrites, calcopyrites, and argentiferous arsenical copper pyrites. In some instances stibina has been found, as well as stains of pyrargyrite or ruby silver.

The silver ore is, properly speaking, the arsenical copper pyrites met at times in an amorphous state, and at others in the shape of tetrahedra crystals. The fracture of the amorphous ore has a greasy appearance that augments as the percentage in silver increases. When the ore is found crystallized it often contains, when clean, 10 per cent. of silver. As far as can be observed, in the case of the lode worked at present by this company, as depth is attained not only does the width of the lode increase, but the percentage of the ore in silver is also found to be greater.

Galena and blende contain silver in proportion to the amount of arsenical pyrites they carry. Pure galena is found to contain 2 per 1,000 of silver, and pure blende about 1 per 1,000.



The silver contained in the arsenical pyrites appears to augment as the percentage of copper increases. The ores at Pulacayo carry only traces of gold. Near the surface the minerals are oxidized and are called "pacos." In an intermediate zone the ores termed "mulatos" are composed of oxisulphides. Below these the lode is unaltered and the ores are called "metales frios."

Table showing the Composition of the Huanchaca Minerals.

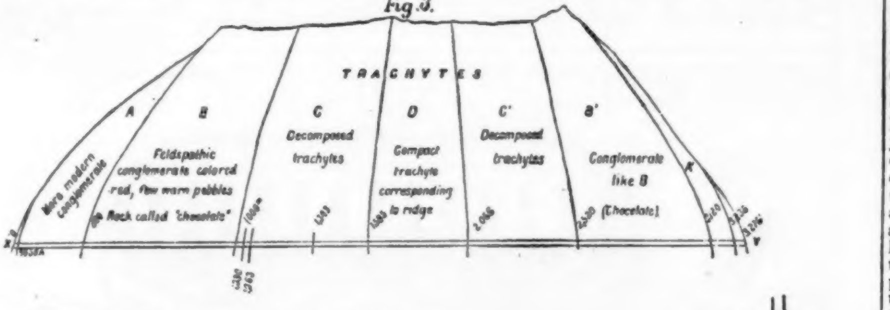
Elements.	Rich ores for exportation.	Minerals treated at Huanchaca and Asiento.	Poor minerals rejected.	Sample of ore* weighing 624 kilogs.
Silver	1·630	0·630	0·340	1·200
Copper	5·875	0·800	3·080	3·300
Lead	8·730	12·070	10·900	10·881
Zinc	16·175	17·540	12·340	23·303
Antimony	0·560	0·560	1·050	traces.
Arsenic	2·880	3·550	5·250	"
Iron	14·666	13·150	0·140	5·147
Sulphur	23·270	21·230	21·200	20·073
Lime	0·810	0·770	0·630	0.535
Silica	24·741	23·010	26·410	35·400
Loss	0·673	0·670	0·780	1·041
Total	100·000	100·000	100·000	100·000

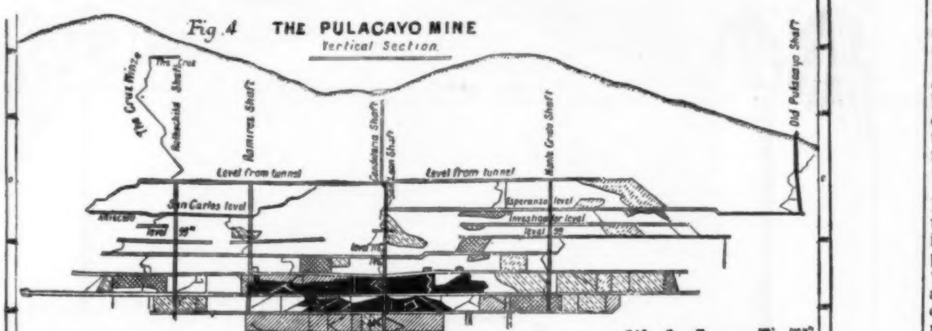
* This sample of ore, containing 1¼ per cent. of silver, was sent to the Paris exhibition.

Elements.	Galenas.	Blendes.	Cupriferous pyrites.	Iron pyrites.
Silver	0·066	0·212	0·368	0·000
Copper	5·280	9·250	5·100	0·000
Lead	45·120	19·370	2·860	0·000
Zinc	14·730	33·000	5·950	traces.
Antimony	2·000	1·760	0·980	"
Arsenic	1·030	0·970	2·070	"
Iron	3·050	5·850	20·230	48·502
Sulphur	17·660	26·200	26·540	48·923
Lime	traces.	1·520	0·600	48·923
Silica	5·890	8·300	31·280	1·600
Loss	0·554	0·168	0·142	0·885
Total	100·000	100·000	100·000	100·000

The company has concentrated its forces in opening out and developing, with the greatest success, the lode of which we give a detailed section in Fig. 4, showing the extent of the underground workings and the richness of the magnificent reserves of ore at sight in the mine.

Fig. 3.





Reserves averaging less than 0,25% — Reserves over from 0,25 to 0,50% — Reserves averaging over 0,50% — Reserves with rich ore averaging from 1% to 3%
Stoped parts of Lode

With the exception of a few strangled points here and there, the thickness of the lode varies from 3 ft. to 9 ft. Its bearing is east-west, and whereas its underlay to a depth of 600 ft. is to the south, it changes here, and below this level it inclines toward the north. The lode has been explored on a length of 3,600 ft., and a total depth of 1,600 ft. With the exception of a few patches here and there, where the lode is poor or sterile, good paying ground is met with throughout the whole extent of this extensive surface.

To within 380 ft. below the tunnel the ore encountered is comparatively poor, but as further depths are attained the lode widens and gets much richer, and up to the present date this increase of wealth has not ceased to be a constant feature of the formation.

The lode is not, however, uniformly rich, as may be seen in the section. Three particularly rich shoots have been followed, and are known to the miners by the names of "Clavo de Uyuni," "Clavo de Delfina," and "Clavo de Julia." They all three appear to incline toward the east.

Between the outcrop and the tunnel level, the lode is almost entirely composed of barytes. With increased depth this gangue diminishes and is substituted by quartz.

Three well-defined faults have been encountered: The first at 98 ft. to the west of the Monte Cristo shaft only throws the lode to a distance of 6 ft.; the second at 320 ft. from the same shaft also produces a throw of 6 ft.; but the third fault at 820 ft. to the east of this shaft throws the lode 219 ft. These faults are directed from N. W. to S. E., with an underlay of 58° toward the south.

The extent of the underground works is considerable. The long tunnel described above had two great objects in view, each of which sufficiently warranted this cross cut being driven. The importance of having a complete section of the formation, leading to the discovery of several other lodes, is evident; but besides this the facilities for transport afforded by the tunnel are great, and lend much assistance to the present general working arrangements.

From the main level driven on the lode in connection with the cross-cut tunnel, four shafts were sunk, as shown on our section. These are the Rothschild, the Ramiry, the San Leon, and the Monte Cristo. The deepest of these shafts is the San Leon, which has attained a depth of 872 ft. The total extent of excavations on the lode is no less than 27,880 ft., of which 23,074 ft. are levels and 4,806 ft. are shafts or winzes.

The section clearly shows the position of the ore in reserve with its respective average percentage of silver. These reserves are estimated by the company to contain 60,000 tons of ore, with an average percentage of 8 per thousand of silver, or over 17½ pounds to the ton. This mass of ore at sight consequently contains nearly 480 tons of silver, representing a value of 2,880,000*l*. It is said also that the accumulated so-called poor ores and tailings in the surface depots contain a large amount of silver, and that, thanks to modern appliances, they will shortly be treated to much advantage.

The present plant comprises two winding and two pumping engines. Two new 80 horse power winding engines, constructed at Anzin, will shortly be erected at the Rothschild and Monte Cristo shafts, by means of which the output is to be considerably augmented.

The Huanchaca Company owns two centers for the metallurgical treatment of their silver ores; the average percentage of silver contained in the ores treated at Huanchaca and Asiento is 6 kilogrammes to the ton (about 13¼ lb.) The nature and composition of the minerals have been shown above.

The method in use at Huanchaca for the extraction of the precious metal from its ore is based on a process of roasting and of amalgamation, which appears to be well appropriated to the local requirements.

The milling plant at Huanchaca is composed of:

A compound 55 horse power engine working fourteen stamp batteries; thirteen amalgamation tanks moved by a Corliss 35 horse power engine, and a 60 horse power hydraulic wheel; five Root boilers of 60 horse power each supply the necessary steam; nineteen double furnaces where the ore is roasted; various arrangements and apparatus for purifying the amalgams, for distilling mercury and melting the silver obtained into bars; workshops where general repairs of all kinds have to be undertaken.

The Asiento Metallurgical Works, situated at thirty-one miles from Huanchaca, are less important, the plant here being composed of: Two stone breakers, six stamp batteries, six roasting furnaces, four amalgamation tanks, one hydraulic wheel, one 30 horse power steam engine, two 60 horse power Root boilers.

The company is further contemplating the erection of large new works for the special purpose of treating the enormous quantities of poor ores (chinis) that have gradually accumulated since the Pulacayo lode has been worked. Considering these poor ores are said to contain from 6 lb. to 7 lb. weight of silver per ton, a very large profit ought to be realized.

The yearly production of Huanchaca may be illustrated by the returns we have before us for 1887. The ore is sorted into three general classes:

1. Three per thousand of silver (6½ lb. per ton) put aside as too poor.

2. Six per thousand to 8 per thousand of silver (13 lb. to 17 lb. per ton) for local treatment.

3. 1·6 per cent. of silver (35 lb. per ton) for exportation.

	Pounds.
In 1887 the Huanchaca Works treated 10,218 tons of ore that produced in silver	115,322
The Asiento Works treated during the same period 2,583 tons of ore that produced in silver	25,884
Total production from local treatment	141,206
During the same year 4,350 tons of rich ores were sold in England, France, and Germany, with an average percentage of 1·54 per cent. of silver, corresponding to a production of	147,683
Making a total production of	288,889

Which at the present rate of 6*l*. 4*s*. per kilogramme corresponds to a value of 800,000*l*.

Besides constructing the railway to Antofagasta, which we learn has recently passed into the hands of an English company, the mining company has considerably improved the port of Antofagasta. A double storied pier advancing 300 feet into the sea has been constructed to facilitate shipping and unloading, while hydraulic cranes and all modern appliances are in use. Extensive workshops have also been established at Antofagosta, which are capable of undertaking any repairs required by marine engines or railway rolling stock.

The supply of water at Antofagasta is so bad that the expense of obtaining the amount required for engines and locomotives is a most serious item in the expenditure of the railway.

To remedy this serious drawback the company has commenced works, with the view of bringing water from a distance of 195 miles. The supply of water, which is to attain 88,000 cubic feet per twenty-four hours, is taken from the source of the St. Pedro at 11,500 feet above the level of the sea.

The directors of the Huanchaca Company may well be complimented upon the results they have achieved, which could only be arrived at by a display of much energy, backed up by judicious and courageous expenditure.—*Engineering.*

THE CREMATION OF THE BODIES OF THE DEAD.*

By WM. B. CLARKE, M.D., Indianapolis. Secretary State Homeopathic Medical Society.

Tabesne cadavera solvat an ignes haud refert.

(Whether decay or fire consumes corpses matters not.)

MY subject, though embracing grave questions, is an anti-grave one, and yet withal not gay; and as science is "the knowledge of things grounded on demonstration, or reducible to practice," that knowledge being dedicated to the general improvement of the human race and its environments, it seems eminently fitting that this scientific body should heartily indorse the movement now making for the general introduction of the scientific incineration of the bodies of our dead as a substitute for burial. Heine tells us that "we do not take possession of our ideas, but are possessed by them. They master us, and force us into the arena, where, like gladiators, we must fight for them." Therefore, I rejoice that the paramount necessity for the adoption of cremation has at last brought many of our great thinkers in all professions to a careful study of its claims and utility, for the more studiously its pros and cons are examined, the more certain it is that the student will rise a sincere convert and proselyte. The medical profession knows that it is the primal duty of every true physician to *prevent* disease and suffering, and secondly to accomplish their cure or relief if he can; and hence it is that the consensus of opinion in the profession is inevitable that, struggle as we may, and use all the known resources of science, except fire, we will never eradicate any of our most dangerous yet common diseases until we adopt the wise precaution of the immediate dissolution, by great heat, of the bodies of those who have died of those diseases. In view of the ghastly facts connected with inhumation, its continuance as a protective measure is about as sensible, or foolish, as the fleeing ostrich's habit of sticking its head under a bush when closely pursued by a hunter.

As the President of the Indiana State Board of Health (Dr. Taylor, ex-president of the Indiana Institute of Homeopathy) writes me: "Could the people in general see this cremation question from the standpoint of the pathologist and the sanitarian, the work would be greatly facilitated"—in fact, would be almost complete. Darwin long ago told us that most of the surface soil which our farmers so much prize has passed through the bodies of earth worms, and been by them deposited on the surface, and Pasteur supplements this with the proof that these same earth worms bring to the surface myriads of bacteria and disease germs from the bodies of the decomposing dead, as has Dr. Domingo Friere, of Brazil, their microscopes showing them in worm and earth, these having power to reproduce their kind in human soil, but being innocuous to the smaller worms themselves. Sir Henry Thompson (an eminent English surgeon) says that "no dead body is ever placed in the soil without polluting the earth, the air, and the water above and about it."

The *Sanitarian* said editorially (January, 1889) that "cases are on record in which typhoid fever has been traced to seepage through the subsoil more than a mile in extent."

The English Rivers Pollution Commission several years ago condemned river water for drinking purposes, after examining 2,000 samples of supposedly potable water, and reported that a small quantity of typhoidal matter in a large quantity of water would cause the fever, a notable instance being cited where 40 cases were caused by running water so contaminated, twenty-five miles away. The nitrates and nitrites in grave-fed water, easily demonstrable, impart to it a peculiarly sparkling, crystal-like brilliancy, and the London *Lancet* says that "the surest carrier and the most deadly virus of contagion is the brilliant and enticing water, charged with the nitrates which result from decomposition."

The influence of ptomaines, those very poisonous alkaloids that result from putrefaction, may play an important part, but for want of time we will not consider them now. If grain two thousand years old rattled from the Egyptian mummy cloth still retains its germinal power, who shall say how long a disease germ can live under similar favorable conditions? In this country we have 30,000 deaths from typhoid fever every year, and 300,000 cases, some of them desperate ones. Will not this number be largely decreased under the sanitary regime of cremation?

Take the disease called scarlet fever, a name that strikes terror to a mother's heart. Its poison is most tenacious, in ground or out, as these two cases will show: Children playing in an attic overhauled an old trunk in which were packed the clothes of a child that had died of that disease five years before, and caught it from them; and the renowned Sir Spencer Wells ("Surgeon to the Queen's Household") tells us that a portion of a Yorkshire churchyard, in which burial

* Read at the annual meeting of the Indiana Academy of Medicine, State House, Indianapolis, December 31, 1889.

had long been forbidden, was finally included in the rector's garden and dug up, whereupon scarlet fever broke out in his family and spread to his neighbors, and the outbreak was traced to the bodies of victims of that disease buried there thirty years before.

It is unnecessary at this time to adduce similar testimony regarding diphtheria or other diseases, or further enlarge upon the sanitary advantages accruing, for the former would be too long and too horrifying, and the latter are self-evident.

The earth was made for the use of the living, not the dead; and "the disposition of the remains of the dead in nowise concerns the deceased, the survivors being the only interested parties" (Sir Henry Thompson). Yet 500,000 acres of the best land near the cities and towns of this country are condemned as sacred to the memory of those who have gone before, and millions on millions of money are sunk on adornment that can at best last but a few years. We are justified in looking at the economical element in favor of cremation, because it is an argument that would be wielded, and perhaps fatally wielded, were it against it. These expensive mortuary displays, often only in rivalry, from custom or family pride, might thus be much curtailed, and their cost devoted to the use of the living most entitled to it, too often those who sadly stand in need of it.

The sentimental objection to cremation—that expressed so beautifully by Longfellow:

> I like that ancient Saxon phrase which calls
> The burial ground God's acre. It is just:
> It consecrates each grave within its walls,
> And breathes a benison o'er the sleeping dust—

is met by the reply that we are under the simple influence of custom, that must be overcome by education along new channels. In short, as in everything else, when we find the best way to do things, do them that way. The question has resolved itself into one of public interest, and as England's premier, Disraeli, said: "What is called God's acre is really not adapted to the country which we inhabit, the times in which we live, and the spirit of the age."

The so-called religious objection to cremation—that it would affect the resurrection of the body at the last great day—is, of course, only a weak superstition. Were it anything more, what, then, as Lord Shaftesbury said, has become of the blessed martyrs who were burned at the stake for their religious belief? As the Holy Writ tells us that "flesh and blood cannot inherit the Kingdom of God," and if "we know that if our earthly house of this tabernacle be dissolved, we have a house not made with hands, eternal in the heavens," how else can the words "ashes to ashes" be appropriately uttered at the last sad rites, except in relation to cremation? And cremation need not discontinue burial in cemeteries, for the harmless ashes resulting can be deposited instead of the body, as was done in Milwaukee, December 13, in the case of Dr. John K. Bartlett, an eminent physician, ex-vice-president of the American Medical Association, incinerated at the Los Angeles establishment, the ashes being sent on by mail at the cost of a few cents. And I will just say that cremation is not, contrary to popular belief, burning the body, as no flames touch it, but dissolving it by great heat.

The objection raised against cremation that a case of felonious poisoning might go undetected needs but slight attention. Such cases rarely pass a physician's scrutiny nowadays, the symptoms belonging to the very few poisons usually used being well understood. In the case of a person who had no medical attendant the coroner would pass on it, and more frequent analysis would add largely to professional knowledge and insure greater benefits to the living. Cremation companies are notoriously more acute regarding actual death and the cause of death than are the burial authorities. The undertakers are now allowed to inject powerful mineral poisons into the bodies of the dead, or the supposed dead, in any amount, unquestioned and with impunity (though there is no absolute proof of somatic death except the fact that decomposition has set in, which takes two or three days). What becomes of the exactness of a posthumous chemical analysis after such a procedure, and what expert would swear that certain poisons thus found were administered ante-mortem or post-mortem?

And any one who has read up on the ptomaine question would be exceedingly chary about being drawn into a description of the difference between the effects of and tests for the vegetable alkaloids and those of the ptomaines. So uncertain and inaccurate is post-mortem evidence of criminal poisoning that no bodies have been exhumed for forensic purposes at Vienna, that great medical center, since 1805; and Bonfanti, for twenty-six years medical expert at the courts of Milan, reports that in the thousands of cases before the court in that time exhumation occurred but ten times, only four leading to the detection of crime—and those four all in one suit, that of Boggia; in which cremation would not have occurred anyhow, for he buried his four victims in his own cellar. Dr. Hugo Erichsen (Detroit) in his book on cremation tells us that the mineral poisons can be detected in the ashes resulting from cremation, and that the vegetable poisons decompose with the body anyhow. There is only one of the vegetable alkaloids that does not behave this way, and this is the one used in the case of Mrs. Petitt, of Lafayette (wife of a Methodist minister, arrested December 5, on the charge of poisoning her), who died July 17, and whose body was exhumed the last week in November, that poison (strychnine) being found. Better that one guilty poisoner should occasionally escape than that thousands of innocent lives be sacrificed.

As to the ultra-utilitarian claim that bodies should in nature be returned to the earth to replace elements lost and needed, we may say that when great wastes and non-applications of this principle are better attended to in other directions, then it will be time to consider this objection.

You do not need to be reminded that, when cremation becomes general, "body-snatching" will be done away with, whether for ransom (as in the case of A. T. Stewart, and as attempted in the case of President Lincoln) or for dissection (as in the case of President Harrison's father).

In conclusion, the history of burial, especially intramural burial, exhumation, and removal, and grave-digging itself is one long roll of disease and death. The interests of the public health demand the abandonment of the practices. Any further upturning of the polluted soil of our old cemeteries should receive its absolute legal quietus immediately, and for sanitary reasons; while for æsthetic reasons we should no longer turn out Yoric's bones to provide lodgment for those of Ophelia. To me inhumation seems inhuman compared with incineration—combustion both—one, slow decay, repulsive and dangerous to the living; the other, transformation, rapid, scientific, and sanitary.

It is the height of folly to go on year after year planting away the tenacious seeds of decimating diseases to be harvested by others who come after. We have the remedy in cremation; and when it is applied the cemeteries and present mortuary methods of our country will have lost their power to scatter sickness and death broadcast in the happy homes of our people.

ELECTRICITY BEHIND THE STAGE.

THOSE who have seen Mr. Neil Burgess in that clever and popular play, "The County Fair," at the Union Square Theater, have been surprised and delighted at the novel effects obtained in the last act, where a horse race is represented with a fidelity to nature rarely attained on the stage. The effect is really wonderful. The electric lights in the theater are flashed out, and after a few moments of inky blackness the flying horses appear at the back of the stage in a blaze of light. They seem to be straining every nerve and fairly flying past a varied landscape. Fences and trees disappear behind them with startling rapidity, and when at last the finish is near, one of the horses gradually works forward, winner by a neck as he approaches the judges' stand; then an instant of darkness, and in the flash of light that follows, the horses are pulled up beyond the stand, and the race is won.

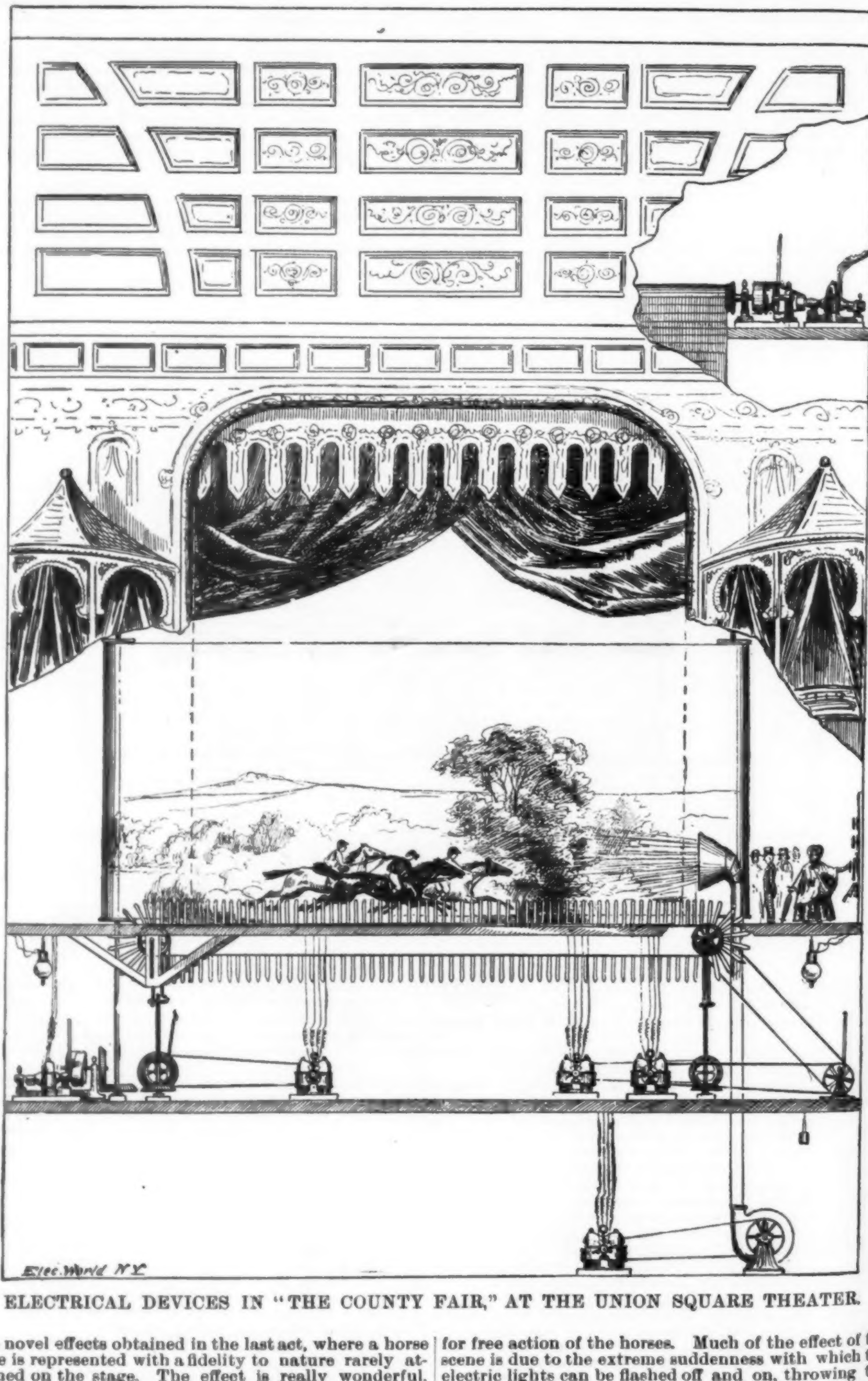
Through the courtesy of Mr. Burgess, who devised the apparatus, we are enabled to give a detailed account of the very ingenious mechanism by which this decidedly remarkable effect is obtained, and it will be specially interesting to our readers, as the electric light and electric motor play a very prominent part in the scene.

Our cut shows a section of the stage and the mechanism below it. As will be seen, the picket fence behind which the horses appear to be running, and the varied scenery that is beyond, are both set in motion by the judicious application of the electric motor, and both form endless belts which move at the same speed past the horses, producing the effect of rapid motion of the animals in a contrary direction. The fence in the foreground, running over flanged wheels, specially adapted for the purpose, has guides that hold it rigidly perpendicular during its passage over the stage.

At the close of the third act the large screws, shown in the figure, are set in motion, and lift the working mechanism of the play up to the level of the floor which had previously covered it. Three flexible endless platforms, passing over rollers at the sides of the stage, serve to complete the illusion by enabling the horses to be in rapid motion without actually moving forward. In fact, so far from moving forward, they are secured by wire rope traces.

At the proper time, as the race nears the finish, the platform on which the winning horse is stationed is gradually slipped forward on a track provided for the purpose until the finish, the actual movement being of course only a few feet. The space between the fence and the scenery behind is 14 feet, giving ample room for free action of the horses. Much of the effect of the scene is due to the extreme suddenness with which the electric lights can be flashed off and on, throwing the stage from extreme darkness to brilliant light and back again in an instant, so that the whole scene appears as a vivid panorama before the audience.

A switchboard on the stage, left, enables one man to control the lights and the mechanism by which the scene is given, and this is in part the reason why electricity has been used so freely. Mr. Burgess himself is enthusiastic on the stage applications of electricity, feeling that by the use of electric motors the whole mechanism of a complicated play can be put under the control of a single man, and manipulated with such facility and rapidity as to very much reduce the waits between acts, and entirely obviate any of the exasperating hitches which otherwise might sometimes occur. He proposes to still further increase the application of motors to his stage setting, and so arrange things that in so far as possible all mechanical devices and movable scenery, curtains and the like, will be handled by motors from one point with great rapidity, and without the danger of trouble from careless attendants. As a matter of fact, Mr. Burgess usually mani-



ELECTRICAL DEVICES IN "THE COUNTY FAIR," AT THE UNION SQUARE THEATER.

pulates the switchboard himself during the last act, as the effects are produced while he is off the stage. He is much interested in things electrical, and proposes during the coming summer to provide himself with an electric launch for his amusement at his summer home, a boat about 25 or 30 feet long, propelled by an electric motor, after the style of the electric boats which have come into some little use on the Thames, near London, but as yet are hardly known in this country. The result of this coming experiment will be watched with interest, as an electrical boat on a practical scale will be rather a novelty hereabout.

The electrical equipment of "The County Fair" is changing with great rapidity, and as improvements suggest themselves they are promptly applied. Although there has been recently some difficulty in getting sufficient electric lights for the theater, we may confidently and constantly expect that electricity will be given a fair chance to show its adaptability to the varied requirements of the theater. If by its use it should prove possible to obliterate completely the long intervals between acts, which in so many theaters are a nuisance, it will be a change for the better which will be enjoyed by all theater goers.

We have devoted some little space to the description of this apparatus, because it is employed to produce really very remarkable effects, the illusion being enough to deceive even the most hardened mechanician, and because Mr. Burgess' interest in electricity will probably lead to great improvements in stage mechanism.—*Electrical World.*

EXPERIMENT IN ELECTRO-MAGNETISM.

IN all cabinets of physics, the celebrated experiment of the Danish physicist Oersted is performed with three quite costly apparatus: the compass, the galvanoscope, and the electric battery. It consists in demonstrating that a conducting wire traversed by a current causes the deflection of a magnetized needle that is brought near it. This experiment is a very important one, since it served as the starting point for the discovery of electric telegraphy. We now propose to show how it can be repeated by the construction of a very simple apparatus.

The materials that it is necessary to procure are the following: A goblet full of water; a bowl or a champagne glass full of water (salted with a pinch of table salt); a teaspoon; a fork; some coke broken into pieces of the size of a cherry pit; a sewing needle; a small magnet; and a strip of zinc about eight inches long and one inch wide.

FUNDAMENTAL EXPERIMENT IN ELECTRO-MAGNETISM.

Let us begin with the compass: Rub the needle against the magnet, always in the same direction, and float it on the water in the goblet, either by oiling it or by sticking it into a piece of paper cut into the form of an animal or man. We know that one of the ends of the needle, the one, for example, corresponding to the feet of the figure, will at once point toward the north.

Let us now pass to the galvanoscope, an apparatus that will indicate the presence of a current by causing a deflection of the needle. To form this, place the teaspoon upon the glass, over the needle and in its direction.

It remains to construct the battery. To this effect, put the pieces of coke in a rag and tie the latter up in the form of a sausage, after placing the handle of the fork in the center. When immersed in the glass of salt water, this coke will form the positive pole of the battery. Now rest the tines of the fork upon one of the ends of the spoon, and upon the other end rest one end of the zinc, whose other extremity dips in the salt water without touching the coke. An electric current will be immediately set up, and the needle will be observed to leave its position of equilibrium, and to return to it as soon as the zinc is removed from the salt water.

RESIN SOAP AS AN EMULSIFYING AGENT.*

By H. COLLIER.

I DESIRE to bring under notice the emulsifying properties of a compound formed by boiling yellow resin with a solution of sodium hydrate, and which I venture to think will be a useful addition to our stock of emulsifying agents. The term soap is here applied to the combination of the acids of resin with alkaline bases, the resulting compound being present, as is well known, in all common yellow soap.

This resin soap I have prepared by boiling gently for two hours in an evaporating dish 1,800 grains of resin with 300 grains of caustic soda, dissolved in one pint of distilled water. Upon cooling, the soap separates as a yellow pasty mass, which is drained from the liquid, well squeezed, then heated on a water bath until it becomes dry and friable, and finally rubbed to powder in a mortar. Made in this way the soap is somewhat like powdered yellow resin; it is soluble in water and rectified spirit; from concentrated solutions prepared by heat, part of the soap separates on cooling, but gelatinization never occurs. The taste is resinous and somewhat acrid. Five grammes dissolved in water, the solution acidulated with hydrochloric acid, and the liberated resin acids separated by ether, after drying, weighs 4·22 grammes, corresponding to 84·4 per cent. of resin.

Mercury shaken in a bottle with a solution of resin soap is immediately broken into very minute globules: as long as this divided mercury is kept moist with the solution, it will not run together. Each globule is coated with a layer of soap, which completely prevents it from coalescing with its neighbor. Chloroform shaken up in the same manner is converted into a permanent cream-like liquid. Ordinary soap and tincture of quillaia act in a similar manner upon mercury and chloroform; in fact, this experiment is a proof of the fact that these substances possess the essential property of an emulsifying agent. Resin soap, compared with sapo durus and sapo mollis B. P., has a more powerful emulsifying effect upon oils, etc., and it possesses also the great advantage of not becoming gelatinous. Compared with tincture of quillaia it appears to give greater viscosity to liquids, so that suspension of the emulsified oil, etc., is more perfect.

A solution of coal tar may be prepared on the lines of the B.P.C. formula for liq. picis comp.:

Resin soap.............................. 2 ounces.
Rectified spirit......................... 1 pint.

Dissolve the soap in the spirit by means of a gentle heat and then add

Prepared coal tar...................... 4 ounces.

Digest at a temperature of 120° F. for two days, allow to become cold, and decant or filter. This solution poured into water forms a perfect emulsion, which does not separate either upon dilution or standing. In the same way can be prepared emulsion-forming solutions of pix liquida, oleum cadinum, and balsam of Peru. The fixed oils, cod liver, almond, olive, and castor, have been emulsified according to the following formula:

Oil .... 1 fluid ounce.
Resin soap........................ 10 grains.
Water................................ 1 fluid ounce.

Dissolve the soap in the water, and shake with the oil. The oil is perfectly emulsified, and there is no separation into layers, even after long standing. It is possible to make an excellent emulsion with only 5 grains of soap, but a separation into a cream and a milky liquid occurs in time. Oleum terebinthinæ, oleum pini sylvestris, oleum pini pumilionis, and pure terebene, when emulsified, are miscible with water in any proportion without separation. This emulsive form will, I think, be found very useful for the preparations of inhalations of volatile oils. These emulsions have been prepared according to the following formula, which is the same strength as vapor olei pini sylvest. B. P., resin soap taking the place of the magnesium carbonate:

Volatile oil................................ ʒ ij.
Resin soap.............................. 10 grains.
Water sufficient to produce 3 fluid ounces.

Dissolve the soap in the water, and shake with the oil. Creasote requires double the amount of soap for perfect emulsification compared with the above volatile oils.

Spirit of camphor containing 5 grains of resin soap in each fluid drachm can be mixed with water, and the camphor remains perfectly suspended. Tincture of tolu with the same quantity of soap is also miscible with water in the same manner. Thymol prepared as follows does not separate on the addition of water:

Thymol.................................. 18 grains.
Rectified spirit .... 3 fluid drachms.
Resin soap .... 20 grains.
Water sufficient to produce 3 fluid ounces.

Dissolve the thymol and soap in the spirit, add the water and shake together.

Oleum santali and copaibæ are emulsified thus:

Copaiba.............................. 1 fluid drachm.
Resin soap........................... 10 grains.
Water sufficient to produce 1 fluid ounce.

I have now given a sufficient number of examples to show that resin soap does possess valuable emulsifying properties which, for certain purposes in pharmacy, may be found useful.

Mr. Kemp said that the subject reminded him of what passed under the name of creolin. He understood that one kind consisted of coal tar emulsified by resin soap. Another kind contained no resin soap, but remained as a perfect emulsion when mixed with water. The question was in what way that kind was emulsified.

Mr. Gerrard said he had taken some little interest in that subject. He had had some creolin in his possession, and after it was exposed to the air for some time he was surprised to find that it became a sort of semi-fluid saponaceous mass, which suggested to him that it contained something in the nature of resin soap. The result of an examination brought him very much to the same conclusion as Mr. Collier had probably arrived at, that resin soap was a most remarkable emulsifying agent. There was just one point Mr. Collier had not referred to in his paper, and that was its action on carbolic acid. If they took liquefied carbolic acid and put it into a few grains of the soap, they might go on adding water without separating it at all; and it would act in the same way with cresol. It was known that some of the popular antiseptics consisted of perhaps the by-products of carbolic acid manufacture, and probably coal tar. The ordinary coal tar when treated with resin soap and diluted with water gave a much darker product than when they diluted the creolin of commerce, and probably the manufacturers were either careful in the selection of their coal tar, or they used mixtures. He was pleased to hear Mr. Collier deal so fully with the preparation of emulsions of essential oils. They wanted some good plan of diluting essential oils, so that the dilutions would remain permanent for some time, and in this direction Mr. Collier had given valuable information.

Mr. Williams said it was only natural to assume that with different resins the composition of the soap would vary, but that given any particular resin, if the instructions were followed, the same kind of soap would result. He should like to know if Mr. Collier had examined the soaps he had prepared to see if they were neutral. In using them for the emulsification of the essential oils, if there were any excess of alkali present it might hold back the volatile oil, and so prevent its use in that direction. In an inhalation an excess of alkali might defeat the purpose of the preparation entirely; but of course it was quite possible that the soap was entirely neutral and that the objection did not arise. He should like to know the best formula for the fixed oils, as certain oils usually required less emulsifying material than others.

Mr. Helbing said on the Continent attention had been given to a resin soap which was very similar to the one Mr. Collier had brought before them, and the saponification was effected by simply heating the resin with carbonate of soda in water, and then pressing the product in a cloth, and afterward drying it at a low temperature. That was recommended against blennorrhœa in the form of pills in 16, 20, or 30 grain doses. Attention was called a few years ago to a fluid creolin which was brought out as a non-poisonous antiseptic. There was resin soap in it, and that was only used to emulsify. It was evident from several analyses made in Germany that the creolins were prepared from the higher homologues of phenol, which were easily emulsified and non-poisonous.

Professor Attfield inquired whether Mr. Collier had tried the emulsifying power of yellow soap, which was at least one-fourth resin soap, and whether the flavor of the resin soap interfered at all with that of any of the emulsions. Had Mr. Collier any hypothesis to offer as to the alleged superiority of resin soap over fatty soaps as an emulsifier?

The chairman said it struck him when Mr. Collier was pouring the solution containing the soap into the glass that it made a splendid emulsion, and he was almost tempted to taste it, but he should like to know whether it would be agreeable to do so. With regard to the spirit of camphor experiment, it was a very old form to use gum myrrh for the purpose, and other gum resins he supposed would do the same.

Mr. Collier in reply said that Mr. Kemp had mentioned that there were two sorts of creolin, one containing resin and the other not. Coal tar could be emulsified without resin by means of an alkali. A gentleman had asked whether the soaps were neutral. The particular specimen he had there contained 0·02 of free alkali, determined in the way in which free alkali in soap was usually determined. The fixed oils varied a good deal in the amount of soap required. Cod liver oil required the least soap, and with five grains he got a mixture which would not separate for some hours. Almond oil came next, and then castor oil, and olive oil, which was the worst. If allowed to stop for an hour, a layer of liquid would be seen at the bottom. Resin soap might be given internally, but the taste was by no means agreeable. It could, however, be covered very well. He had made a cod liver oil emulsion with it on the lines of the unofficial formulary recipe, which had been very much appreciated. The only reason he did not at present recommend its use internally was that he did not exactly know what effect it might produce, and he should like some one to make experiments to determine this. It might be given up to 30 grains. Carbonate of sodium might be used, but he thought the solution of caustic soda was better. The percentage of alkali varied with different resins. He found that if he went up to a soap of 1 in 7 or 1 in 8 it was rather difficult to dry it, and so he thought 1 in 6 would be a very good formula. It would be remembered there were such things as basic soaps. An ordinary neutral soap when boiled with alkali would take up more alkali, but of course that soap when it was put into water would break up and liberate alkali. His attention was drawn to the superiority of that soap by using common soap. Resin was now used in the manufacture of ordinary soaps, though they contain fatty acids as well. Strong solutions of ordinary soaps could not be made. They might make a solution of 1 in 10, but with resin soap they could make one of 1 in 5. Another advantage was that it was much easier to obtain a definite product than it was with ordinary soap.

THE FUNCTION OF AMMONIA IN THE NUTRITION OF PLANTS.*

THE question in what form nitrogen is absorbed by the roots of plants has given rise to many investigations. It was first believed that the nitrogen of organic matter could contribute directly to the nutrition of plants. Boussingault, however, showed that nitrogen could only be taken up in the form of

* Read before the Pharmaceutical Society of Great Britain, London, March 12, 1890.

* Communicated by M. A. Muntz to the Academie des Sciences.

some salt of a mineral acid, and at a period already becoming remote this property of being assimilated by plants was ascribed to salts of ammonia alone. Even Kuhlmann, after having confirmed the beneficial effect of nitrate of soda as a fertilizer, imagined that this salt was first converted into ammonia in the soil by reducing agents. This opinion held its own for a long time, even although Boussingault showed that nitrates are directly absorbed by plants.

At the present time, however, the inverse of this theory tends to prevail, and it is generally believed that the nitrogen of plants is assimilated in the form of nitrates, and that, in opposition to Kuhlmann's views, ammonia must pass through the form of nitrate before being utilized.

There is, therefore, a doubt as to the true part played by ammonia, which the researches hitherto instituted do not seem to have fully removed. At first sight, it appears easy to solve a problem which can be so simply stated, but the conditions are greatly complicated by the existence of a nitrifying ferment. The good effect of ammonium sulphate upon vegetation is established beyond a doubt, but it is difficult to ascertain whether this is due to the ammonia itself or to the nitrate formed from it in the soil. In order to determine the actual function of the ammonia, its action must be studied under conditions which do not admit of nitrification taking place.

I have carried out experiments arranged with the object of answering the question, "Can the salts of ammonia serve as nourishment to plants without previous transformation into nitrates?"

The necessary conditions may be realized by allowing plants to grow in a soil deprived of nitrates, removed from the action of the nitrifying ferment, and only containing ammoniacal salts as a nitrogenous manure.

The experiments were carried out by washing out all the nitrates from soil taken from the fields, adding ammonium sulphate, and placing it in large pots, which were put in a stove heated to 100°, a temperature more than sufficient to kill the nitrifying ferment. The soil was, therefore, free from nitrates and nitrifying organisms. It was then necessary to guard against all casual contamination of the soil, which was done by the use of large cases, some of the sides of which were glazed, and the others replaced by filtering cloths, which allowed the air to pass, but retained all dust, germs, etc. After being sown, the grains were subjected for a short time to the temperature of boiling water, by which means any germs existing on their surfaces were destroyed. All these operations were carried out in a closed chamber, the atmosphere of which had been purified by the action of fine jets of water, and then left undisturbed.

After the introduction of the pots, the cases were placed under an open shed. The seeds were watered with sterilized water.

Vegetation was produced, therefore, in a medium deprived of nitrates, and freed from all nitrifying organisms. For the sake of comparison, other cases were prepared in a similar manner, but to each was added a small quantity of earth containing the nitrifying ferment.

Two sets of experiments were, therefore, being conducted simultaneously—one with soil containing ammonia only, the other with soil containing an organism capable of nitrifying the ammonia. The investigations carried on in the years 1885–1888 have given concordant results. The examination of the sterilized earth showed that no nitrates had been formed, even at the end of several months, so that the plants grown in it can only have been able to obtain their nitrogen from the ammonium sulphate. The following numbers show the quantities of nitric acid per kilogramme of soil at the commencement and end of the experiments:

	Earth freed from nitrifying organisms.		Earth containing nitrifying organisms.	
	Commencement. Mgrm.	End. Mgrm.	Commencement. Mgrm.	End. Mgrm.
1	0·0	0·0	0·0	91·2
2	0 0	0·0	0·0	420·0

The plants, on the whole, grew in a satisfactory manner; maize, beans, horse beans, and hemp grew to a height of more than a meter. By determining the amount of nitrogen in the several plants, and subtracting that which was contained in the seeds, we can discover whether the plant has utilized the nitrogen of the ammonia. The following are some of the results obtained:

	Nitrogen.		
	In the Seed.	In the Plant.	Difference taken up from the Ammonia.
Beans	37	956	914
Horse beans	16	105	89
Maize	3	211	208
Barley	0·7	50	49·3
Hemp	0·5	115	114·5

The quantities are all in milligrammes.

These experiments show in the clearest manner that plants are able to directly absorb the nitrogen of ammonia through their roots, and that consequently the nitrification of ammoniacal fertilizers is not an indispensable condition of their utility.—*L'Engrais, in Chem. Trade Jour.*

A HYDROCARBON FURNACE FOR ASSAYING, ETC.

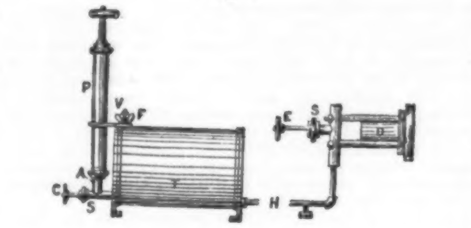
By GEO. E. R. ELLIS, F.C.S., of Montana.

I HAVE ventured in this paper to give particulars of a piece of apparatus which my own experience—confirmed by that of many other assayers—has shown to be eminently serviceable as a readily controllable source of intense heat, such as is required by analysts, assayers, metallurgists, and others. This furnace has been before the American public for several years and is therefore past the experimental stage, but as far as I am aware, it is comparatively or wholly unknown to the English scientist.

Assayers know full well that there are many inconveniences and annoyances necessarily connected with the use of furnaces burning coal or coke; this apparatus, on the contrary, does away with the constant replenishing of fuel, with all dust and ashes, and with a large amount of radiated heat; indeed, it may be said that it possesses all the advantages of a gas furnace, with the additional advantage that it may be forced to practically any extent without the use of a blower or foot bellows. Once pumped up—which operation occupies only a few seconds—the blast will continue for a long time without further attention.

The apparatus consists of three parts (each of which may be procured separately), viz., the tank and blowpipe, the muffle furnace, and the crucible furnace. The tank and blowpipe are represented in Fig. 1. P is an ordinary force pump, at the bottom of which, at A, is a valve which closes automatically upon releasing the pressure from the pump. C is a check valve which closes the inlet to the tank, T, completely; F is a filling screw for introducing the fuel used, viz., gasoline;

Fig. 1.



V is a vent screw for letting off the pressure when the operation or experiment is finished; H is a pipe leading from the tank to the burner, D; E is the burner regulator, terminating in a fine point, closing the orifice of the burner; S S are packing boxes. Upon opening C and pumping a few strokes a pressure is created in the tank and *on top* of the fluid, forcing it through the tubes of the burner, which being previously heated vaporize the gasoline. This issues from the orifice at the end of E as a highly heated gas, and burns as such in the form of a powerful blast. After being once started the heat of the flame passing through the burner, D, vaporizes the fluid in the tubes, and hence the apparatus is automatic.

The air which is forced in is not consumed, so that to keep up the blast it only requires a few strokes of the pump occasionally (every half hour or so) to maintain the pressure lessened by the consumption of the gasoline.

The way to start the blowpipe is simple and as follows: Close E, unscrew F, and introduce gasoline according to the capacity of the tank. Replace F, close V; open C one or two turns, and give three or four full strokes of the pump, P, then close C. Heat the burner by burning some of the gasoline in a suitable vessel (an old scorifier will do well) placed under the burner; when hot apply a match and open E gradually until the action is more or less uniform. The burner is hot enough when no *liquid* or *spray* issues from the orifice; if not hot enough let the oil burn slowly until no liquid or spray issues. When sufficiently heated, the blast can be made of any desired intensity by the use of the force pump as above. The mouth of the burner, D, should be 2–3 inches from the inlet of either furnace, otherwise the combustion in the interior of the furnace will not be complete. To stop the action of the blowpipe, simply shut the regulator E, or open screw, V, or do both. When not in use, keep V open.

For very high temperatures or muffle work we proceed as follows:

(1.) Light as above, and heat inside of furnace to bright redness.

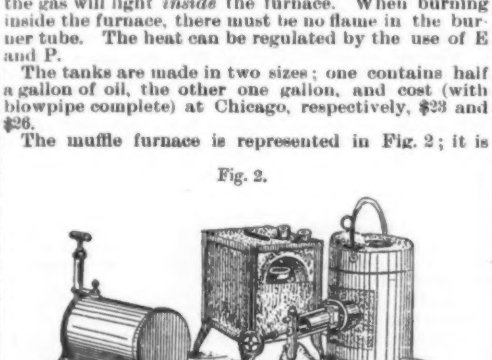
(2.) Place the burner *against* the inlet of the furnace.

(3.) Turn out burner flame with E, and immediately turn it on again without lighting it (or simply blow the flame out), when, if the furnace is hot enough, the gas will light *inside* the furnace. When burning inside the furnace, there must be no flame in the burner tube. The heat can be regulated by the use of E and P.

The tanks are made in two sizes; one contains half a gallon of oil, the other one gallon, and cost (with blowpipe complete) at Chicago, respectively, $23 and $26.

The muffle furnace is represented in Fig. 2; it is made in two sizes, the one taking a "C" Battersea muffle (8 in. long × 4¾ in. wide × 3 in. high), the other an "F" Battersea (10 × 6 × 4). The inlet for the blast is opposite to and below the mouth of the muffle, and cannot be seen in the cut. The muffle furnace requires a length or two (not more) of stove pipe in order to create a draught through the muffle, or they may be connected with a flue; in the latter case a damper must be put in the pipe, for too much draught is prejudicial.

Fig. 2.



The smaller muffle furnace costs $10, the larger one $15.

Figs 3 and 4 represent the two kinds of crucible furnace; Fig. 3 being adapted for taking one crucible at a time, Fig. 4 for taking two or four crucibles at the same time.

The No. 1 furnace costs $4, and takes a crucible 4 in. in diameter; and 5½ in. deep inside; No. 2 takes a crucible 5 in. in diameter and 6½ in. deep inside, and costs $5; No. 3 costs $7, and takes two crucibles, 4 in. in diameter; while No. 4 costs $12, and can take four No. 10 French crucibles, or equivalent sizes.

We will now consider some of the conveniences attending the use of this apparatus.

Cost of Running.—This naturally depends upon the local price of the fuel used as the source of heat, viz., gasoline. In a large city, *e. g.*, Chicago or New York, the cost per hour does not exceed 3 cents (1½d.), while 5 cents may be put down as the maximum in out of the way districts. A certain prejudice exists against the use of gasoline, but, from its construction, no accidents can happen from the use of this apparatus save as the result of gross carelessness.

Power of Furnaces.—The heat of the blowpipe can be controlled from that of a Bunsen burner to that required to melt cast iron. Using the crucible furnace, ½ lb. of cast iron can be melted in 15 minutes (furnace cold at the start), or 1 lb. of brass can be melted in 7 minutes (furnace hot at the start). The muffle furnace can be heated to a scorification temperature in 15 minutes. Six scorifications can be performed at the same time in the larger furnace.

Fig. 3.

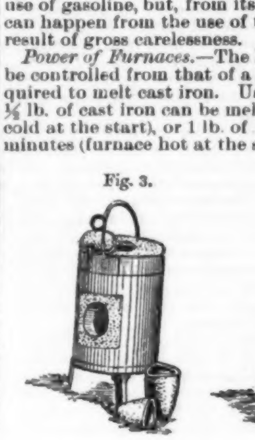
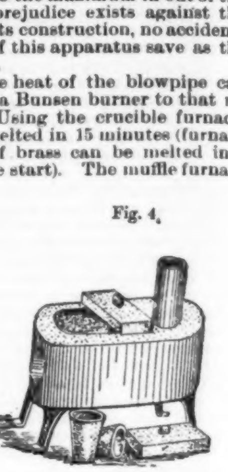


Fig. 4.



Amount of Heat Radiated.—In this respect these furnaces will compare favorably with any in the market. The following readings were taken with the larger size muffle furnace during the scorification of some copper-silver ores:

Distance from side (or front) of muffle.	Temperature.	Distance from side of muffle.	Temperature.
5 ft. (front)	17° C.	9 in. (side)	42° C.
22 in. "	21° C.	6 in. "	52° C.
18 in. "	28° C.	3 in. "	81° C.
19 in. (side)	26° C.	1 in. "	106° C.
12 in. "	34° C.		

The temperature of an ordinary room at the same time was 16° C.

The general compactness of the apparatus is also a feature in its favor; the larger size muffle furnace stands 14 in. high, is 9 in. wide, and 12½ in. long, while the corresponding measurements for the crucible furnace taking two crucibles at a time are 10½, 8, and 14½ in. respectively. The whole apparatus can be conveniently used on a table 4 ft. long by 2 ft. 3 in. wide. It is also to be noticed that the burner in Hoskin's apparatus is *outside* of the furnace during the whole of the operation, and is, therefore, not subjected to the destructive influence of very high temperatures, as is the case in many forms of furnaces using ordinary coal gas as a source of heat.

Note.—Since writing the above I find that a muffle furnace is now manufactured sufficiently large to accommodate a 15 in. by 9 in. muffle. This furnace is heated by two blowpipes of the same size and power as described in the above paper.

FERTILIZING MATERIALS.*

By EDWARD B. VOORHEES, Chemist.

1. *Prices of Nitrogen, Phosphoric Acid, and Potash.*
2. *The Economical Purchase and Rational Use of Nitrogen, Phosphoric Acid, and Potash.*

1. PRICES OF NITROGEN, PHOSPHORIC ACID, AND POTASH.

Schedule of Trade Values adopted by Experiment Stations for 1890.

	Cents per lb.
Nitrogen, in ammonia salts	17
" " nitrates	14½
Organic Nitrogen in dried and fine ground fish, meat and blood	17
" " " castor pomace and cotton-seed meal	15
" " " fine ground bone and tankage	16½
" " " " medium " " "	13
" " " " " " "	10½
" " " coarser " " "	8½
" " " horn shavings, hair, and coarse fish scrap	8
Phosphoric Acid, soluble in water	8
" " " " ammonium citrate†	8
" " insoluble in dry ground fish, fine bone and tankage	7
" " " " fine medium bone and tankage	6
" " " " " " " "	5
" " " " coarser " " "	4
" " " " fine ground rock phosphate	2
Potash as high grade sulphate, and in forms free from muriates (or chlorides)	6
" " kainit	4½
" " muriate	4½

The above is a schedule of the prices to be used at this station in calculating the value of commercial fertilizers during the season of 1890. These prices have been carefully considered and are approved for the experiment stations of Connecticut, Massachusetts, Pennsylvania, and New Jersey.

They also closely correspond to the average wholesale prices of raw materials for the six months ending March 1, plus about twenty per cent.

The calculated values of the different fertilizing materials, obtained by the use of the schedule of prices, will be found to agree closely with their present retail price at factory, and are, therefore, intended to represent the retail cash cost of the nitrogen, phosphoric acid, and potash contained in them before they have been mixed to form a complete fertilizer. After analy-

* From the Bulletin of the New Jersey Agricultural Experiment Station.

† The solubility of phosphates in ammonium citrate solutions is seriously affected by heat. An act of the Legislature (see "Laws of New Jersey," 1874, page 90) provides that in this determination the temperature used shall not exceed 100 deg. F.; in Connecticut, Massachusetts, and Pennsylvania, 150 deg. F. has been adopted. The higher the temperature, the larger will be the percentage of phosphoric acid dissolved by ammonium citrate solutions; and the larger the amount of this so-called "reverted" phosphoric acid in a ton of superphosphate, the lower will be the price per pound of said acid. Consequently, the Station's valuations of phosphoric acid, soluble in ammonium citrate, have been fixed at *seven and one-half cents per pound* for Connecticut, Massachusetts, and Pennsylvania, and at *eight cents per pound* for New Jersey.

ses have been secured, these prices also furnish the data for comparing the cost and relative commercial values of the different brands of complete fertilizers offered in our markets.

2. THE ECONOMICAL PURCHASE AND RATIONAL USE OF NITROGEN, PHOSPHORIC ACID, AND POTASH.

To consumers of commercial fertilizers a knowledge of the kind, the cost, and the average composition of unmixed fertilizing materials is important, and the frequent inquiries from farmers indicate a desire for detailed information on these points. Such information is, therefore, presented in the following table.

The materials containing but one element in readily available forms and in definite amounts are termed standard, and are divided into distinct classes, furnishing: 1, nitrogen; 2, phosphoric acid; 3, potash; while those furnishing two or more elements, which vary in composition and availability between reasonably narrow limits, are grouped under another head.

Other materials, largely waste products, are on the market, and have a recognized value, but are not sufficiently uniform in composition to be included in the classification.

Table showing the Principal Fertilizing Materials, and the Average Amount in Each of Nitrogen, Phosphoric Acid, or Potash.

Kind of Material.		Containing Pounds per Hundred of			
		Nitrogen.	Phosphoric Acid Available.	Phosphoric Acid Insoluble in Water.	Actual Potash.
Nitrogen	Nitrate of soda	16·0	....	....	....
	Sulphate of ammonia	20·0	....	....	....
	Dried blood, high grade	14·0	....	....	....
	Ammonite, high grade	12·0	....	3·0	....
Phosphoric acid	Bone-black superphosphate	....	16·0	....	....
	S. C. rock "	....	12 0	3·0	....
Potash	Muriate of potash	....	....	....	50·0
	High grade sulphate	....	....	....	50·0
	Double sulphate	....	....	....	26·0
	Kainit	....	....	....	12·5
Nitrogen, phosphoric acid and potash	Ground bones	3·5	....	20·0	....
	Dissolved bones	1·5	12 0	15·0	....
	Dried fish	7·0	....	7·0	....
	Tankage	7·0	....	10·0	....
	Cotton seed meal	7·0	....	3·0	2·0
	Castor pomace	6·0	....	2·0	1·0

The above table shows, first, that fertilizing materials furnish nitrogen, phosphoric acid, and potash; and, second, that they exist in the different materials in different forms and quantities. These actual elements have a definite commercial value, which varies from year to year as the conditions of the markets change.

It is evident, therefore, that the direct value to the farmer of any fertilizing material is determined by the amount and kind of the actual fertilizing elements which it contains.

The economical purchase of fertilizers from the commercial standpoint depends not only upon the high or low price paid per ton, but also upon the relation which exists between the price per ton and the amount of the elements furnished, *i. e.*, upon the cost per pound of the nitrogen, phosphoric acid, and potash.

This may be illustrated as follows: A buys a fertilizer for $34 per ton, guaranteed to contain 4 per cent. nitrogen, 10 per cent. available phosphoric acid, and 5 per cent. potash; while B buys one for $30 per ton, guaranteed to contain 2 per cent. nitrogen, 8 per cent. phosphoric acid, and 3 per cent. potash. Assuming that in both cases the materials used are secured from the best sources, in the case of A the actual cost would be 17 cents per pound for nitrogen, 8 cents for phosphoric acid, and 4½ cents for potash, while that of B would furnish nitrogen at 22·6 cents, phosphoric acid at 10·6 cents, and potash at 6 cents per pound.

In the case of the higher cost per ton, the materials are furnished 33 per cent. cheaper than in the lower cost per ton.

The buying of fertilizers is, therefore, virtually a buying of pounds of nitrogen, phosphoric acid, and potash. In purchasing them in the form of concentrated unmixed materials, a saving is effected in the actual cost, and a definite knowledge of their quality is obtained.

While these points are important and should be observed by the careful and progressive farmer, there is in the consideration of this subject another point of equal and, perhaps in many cases, of still greater importance, viz., rational use. Economical buying should be accompanied by rational use.

Among the first questions that are asked by those farmers who are interested in this subject are:

1. What is the best fertilizer for wheat, corn, oats, potatoes, etc.? as the case may be; and

2. How much shall I use per acre?

These are pertinent and practical questions, and it would seem to be the province of the Experiment Station to at least give such information as shall guide in their solution.

It should be remembered in this connection that nitrogen, phosphoric acid, and potash are necessary for the full development of farm crops, and that the different crops have different capacities for using them; it is also true that when no increase in crop follows the proper application of any one or all of these elements, the crop has sources at command which provide sufficient quantities to develop it to that limit fixed by the existing conditions of climate and season.

In view of these facts, the best fertilizer resolves itself into the best or most economical quantity of nitrogen, phosphoric acid, or potash to be used under the varying conditions of crop, soil, and season. It is obvious, therefore, that an accurate and definite answer to the first question is impossible.

A careful study of the different crops, and their capacities for using the different elements, however, furnishes data which may be used within reasonable limits in answering the question how much should be used per acre.

The amount and proportion of the elements that may be found profitable for the different crops under average conditions are indicated in the following table:

Average Amounts of Nitrogen, Phosphoric Acid, and Potash per Acre.

No.	Crops.	Nitrogen.	Phosphoric Acid.	Potash.
		lb.	lb.	lb.
1	Wheat, oats, rye, corn	16	40	30
2	Potatoes and roots	20	25	40
3	Garden produce	30	40	60
4	Fruit trees	25	40	75
5	Clover, beans, peas, etc.	..	40	60

Individual farmers must determine for themselves whether for their land and their crops single elements may not be more profitable than any combination of two or more; the physical condition of the soil, and its previous cropping and manuring, must also guide the farmer in deciding whether the amounts given in the table should be increased or diminished. As a broad, general rule, greater immediate profits are secured from heavy dressings on land in a high state of cultivation than on farms of average fertility.

FORMULAS FOR MIXTURES.

In order to supply the amounts of nitrogen, phosphoric acid, and potash to the different crops as indicated in the last table, the following formulas have been prepared.

An application of 500 lb. per acre of a mixture of 350 lb. of S. C. rock superphosphate and 650 lb of kainit would furnish the same amounts of phosphoric acid and potash as No. 5, and would be equally good, though such a mixture would have a tendency to harden.

The best forms of fertilizing materials were used in the preparation of these formulas, as they will probably be found to be the cheapest in the majority of cases. These are, as a rule, in good mechanical condition, and can be bought direct from the leading dealers or manufacturers, and should in all cases be accompanied by a guaranteed composition.

MIXING.

It is important that the materials should be evenly mixed. This can be easily done by forming on the barn floor or other dry and level place a series of layers of the different materials and working the heap over from the edge outward, breaking all the lumps in the process; a few turnings will suffice to answer the purpose. Screening is also advisable if suitable apparatus is at hand.

It is not claimed that the buying of raw materials and mixing at home is the best and cheapest method of getting fertilizers under all conditions; however, the important points in favor of the method will bear repeating, viz.:

1. That a definite knowledge of the quality of the materials is secured; and

2. That where farmers know what they want and unite in purchasing car lots, there is a decided saving in the cost of the plant food.

The station recommends that both individual farmers and farmers' clubs give this method a practical trial, and it is ready to co-operate with them so far as to make such analyses of the goods bought as is deemed wise. It is desired, therefore, that when unmixed materials are purchased, either for application singly or for home mixing, the parties so buying notify the station, in order that the properly authorized persons may procure samples and forward them to the station.

A NEW EYE.

By CAMILLE FLAMMARION.

IT cannot be gainsaid that the human eye is an admirable optical instrument. What transparency in this living crystal, what delicious shades of color in this iris, what depth, what charm! It is life, it is a desire, it is the will, it is light! Close all these eyes, what would remain of creation? And, nevertheless, we have here a new eye—complementing our own and excelling it—still more marvelous. This eye whose visions I have just admired measures more than a meter in diameter, and fifteen meters in depth. Its crystalline lens is formed of an immense piece of glass, and its retina of a highly sensitive chemical plate. The eye of a giant, in verity, as the man possessing it should measure in our organic proportions 100 meters in height, and he would not be able to pass under the Eiffel Tower without humbly bending. A gigantic eye, possessing four marked advantages over ours. It sees *quicker, farther, longer*, and, precious faculty, it fixes, prints, and preserves what it sees.

Quicker: In the millionth of a second it photographs the sun, its spots, its vortices, its flames, its mountains of fire, and gives them to us in the form of an imperishable document. Farther: Directed toward any point of the heavens, in the darkest night it discovers in the abysses of the infinite stars, worlds, universes, creations which our eye could never see with the aid of the best telescope. Longer: That which we have not been able to see after a few seconds' attention, we shall never see. This eye only has to look long enough, at the end of a half hour it will distinguish what it did not see; at the end of an hour it will see still better, and the longer it remains fixed upon unknown space, the better it will possess it—without fatigue, and always better; and it preserves on the plate serving as its retina all that it has seen: our eye retains images but a moment.

Let us suppose, for example, that a man is killed at a moment when quietly seated in his arm chair, and having his eyes opened before a brilliantly lighted window, and that his eyes should be removed and im-

No. 1. Wheat, Oats, Rye, Corn.

To Make 1,000 lb. of Mixture.		Containing Pounds of		Application per Acre.
Nitrate of soda	100 lb.	Nitrogen	40	400 lb.
Sulphate of ammonia	50 "			
Dried blood, high grade	100 "			
Bone-black superphosphate	600 "	Phosphoric acid	96	
Muriate of potash	150 "	Potash	75	

No. 2. Potatoes and Roots.

To Make 1,000 lb. of Mixture.		Containing Pounds of		Application per Acre.
Nitrate of soda	125 lb.	Nitrogen	51	400 lb.
Sulphate of ammonia	100 "			
Dried blood, high grade	75 "			
Bone-black superphosphate	400 "	Phosphoric acid	64	
High grade sulphate of potash	100 "	Potash	102	
Double sulphate of potash	200 "			

No. 3. Garden Produce.

To Make 1,000 lb. of Mixture.		Containing Pounds of		Application per Acre.
Nitrate of soda	100 lb	Nitrogen	54	600 lb.
Sulphate of ammonia	125 "			
Ammonite, high grade	100 "			
Bone-black superphosphate	400 "	Phosphoric acid	64	
Muriate of potash	110 "	Potash	98	
Double phosphate of potash	165 "			

No. 4. Fruit Trees.

To Make 1,000 lb. of Mixture.		Containing Pounds of		Application per Acre.
Nitrate of soda	250 lb.	Nitrogen	47	500 lb.
Ground bones	200 "	Phosphoric acid	80	
Bone-black superphosphate	250 "			
Muriate of potash	300 "	Potash	150	

The following formula may be substituted for No. 4, with the additional application in the spring of 100 lb. per acre of nitrate of soda:

To Make 1,000 lb. of Mixture.		Containing Pounds of		Application per Acre.
Ground bone	300 lb.	Nitrogen	11	350 lb.
Bone-black superphosphate	300 "	Phosphoric acid	108	
Muriate of potash	400 "	Potash	200	

No. 5. Clover, Beans, Peas, etc.

To Make 1,000 lb. of Mixture.		Containing Pounds of		Application per Acre.
Bone-black superphosphate	500 lb.	Phosphoric acid	80	500 lb.
Muriate of potash	150 "	Potash	120	
Kainit	350 "			

mersed in a solution of alum. These eyes would preserve the image of the window, with its transversal bars and its illuminated openings. But in the normal condition of things, our eyes do not retain images—there would be too many. The giant eye of which we speak retains all that it has seen; we have only to change the retina.

This new eye is the photographic eye. The principal astronomers of the world have just met at the Paris Observatory in order to decide on its immediate application to a new and complete study of the starry heavens. Magnificent specimens of photographs of the moon, the sun, the stars, the nebulæ, and even of the planets, were presented to the congress, and showed what may be expected from the new processes. Some photographs among them show us the lunar mountains and craters, such as they would be seen at a distance of forty leagues.

Yes; this artificial retina sees quicker and better, and by an absolutely different faculty it can penetrate into abysses into which we cannot see, and will never be able to see anything. We have here, perhaps, its most extraordinary feature.

Let us place our eye, for example, to the eye piece of a telescope whose objective has an opening of thirty centimeters—these are the best instruments now in practical use in observatories. In this telescope of thirty centimeters in diameter and of three and a half meters in length, we discover stars up to the fourteenth magnitude—that is to say, about 44,000,000 of worlds of all kinds. Now, instead of our eye, let us use the photographic retina. Instantly the most brilliant stars will imprint their image on the plate. Five thousandths of a second suffice for stars of the first magnitude, one hundredth of a second for stars of the second magnitude, three hundredths of a second for those of the third, one tenth of a second for those of the fourth order, two tenths for those of the fifth order, and five tenths of a second for stars of the sixth magnitude. Thus, in less than one second, the photographic eye has seen all that we can perceive with the naked eye. But this is yet nothing. The telescopic stars visible in the instrument will also imprint their image on the plate. Those of the seventh magnitude require one and one third seconds, those of the eighth magnitude three seconds, those of the ninth magnitude eight seconds, those of the tenth twenty seconds, those of the eleventh magnitude fifty seconds, those of the twelfth require two minutes, those of the thirteenth five minutes, and finally those of the fourteenth, thirteen minutes. It follows that, if we have given our plate an exposure of one quarter of an hour, we will find imprinted on this plate all that portion of the heavens toward which the glass had been directed, and all that that region possesses—all that which with infinite trouble we might have been able to discover, to measure by a series of laborious and very lengthy observations. A sufficient number of instruments pointed so as to embrace the whole of the heavens will fix on an immense chart all that astronomical observations can study, and which could only have been obtained after a lapse of several centuries.

But here is only the commencement of the marvelous. Let us allow the photographic eye to look instead of our own; it will penetrate into the unknown. Stars invisible to us become visible to it. At the end of an exposure of thirty-three minutes, the stars of the fifteenth magnitude will have impressed the chemical retina and formed their image. The same instrument which shows to the human eye stars of the fourteenth magnitude, and which in the entire heavens would register about 44,000,000 of stars, shows to the photographic eye 134,000,000 at the first requisition for obtaining the fifteenth magnitude. It would reach the sixteenth at the second requisition, in an exposure of one hour and twenty minutes, and throw before the astonished gaze of the beholder a luminous dust of *four hundred millions of stars.*

Never before, in all the history of humanity, has man possessed the power of penetrating so profoundly into the depths of the infinite. With the new improvements, photography gives us clearly the image of each star, whatever its distance, and fixes it on a document where it may afterward be studied at leisure. Who knows, if at some future day, in the photographic views of Venus or of Mars, a new method of analysis will not enable us to discover the inhabitants; and its power extends as far as the infinite. Here is a star of the fifteenth, sixteenth, seventeenth magnitude, a sun like our own, at such a distance from us that its light requires thousands, perhaps millions, of years to reach us, notwithstanding its prodigious velocity of 300,000 kilometers in a second; and this sun lies at such a depth that its light, so to speak, no longer reaches us. The natural eye of man would never have seen it, the human mind would never have guessed its existence with the instruments of modern optics; and yet this feeble light coming from so far is sufficient to impress a chemical plate, which will indelibly preserve its image. And this star might be of the eighteenth, of the twentieth order, and still smaller, so small that never human eyes, assisted even by telescopes of the highest power, will see it—for there will always be stars beyond our vision; and, nevertheless, with its little ethereal arrow it will reach the chemical plate exposed to await its coming and to receive it. Yes; its light will have traveled for millions of miles. When it started the earth did not exist—the present world with its inhabitants; there was not a thinking being on our planet; the genesis of our world was about being developed; perhaps only in the primordial seas which enveloped the globe before the upheaval of the first continents. The elementary primitive organisms were being formed in the bosom of the waters, slowly preparing the evolution of future ages. This photographic plate sends us back to the past history of the universe.

During the ethereal voyage of this luminous ray, which to-day reaches this plate, the entire history of the world was accomplished, and in this history that of humanity is but a ripple—but a moment. And during this time the history of this distant sun, whose photograph we now see, may also have been accomplished; perhaps it has long been extinguished, perhaps it no longer exists!

This new eye that carries us through the infinite causes us at the same time to ascend the stages of a past eternity.

Eternity! The infinite! Contemporaneous astronomy plunges us into their depth and overwhelms us. How can we measure them? Flying with the quickness of the lightning, it would require millions of years to reach the regions in which these distant universes shine, but carried thither, we would not really have advanced a single step toward the limits of space—as space is without boundaries, the infinite without measures, and everywhere, in all directions, there are so many worlds, so many consecutive suns, that if we were to give the photographic plate the sufficient exposure, it would be covered with contiguous luminous points, so close as to only show one heaven of dazzling light; as everywhere, to whatever point we may direct the visual ray, there is an infinity of suns back of each other.

And we live on one of these worlds, on one of the most insignificant, at some point of the limitless immensity, receiving the light from one of these innumerable suns, in a limited horizon, a veritable cocoon of the silk worm, ignorant of all the causes; ephemeral of a moment, imbued with an illusory view of the world, hardly seeing anything, insignificant enough to imagine that we know something, even flattering ourselves with a sanctimonious sentiment of pride to be able to dominate nature, proud of an illusion mistaken for reality, we solve all questions. We call ourselves materialists without knowing one word of the essence of matter; spiritualists, without knowing a word of the nature of the spirit, but at the bottom of all thinking beings skepticism resides, because we are incapable of appreciating anything. Our lost little planet is still too vast for our conception, as we have invented local patriotism, and the whole organization of the divers social groups which divide the world between them is founded on the force of arms. Ah! the astronomer would wish that the leaders of the people, the legislators, the politicians, had the faculty to look at a celestial chart and to understand it. This calm contemplation might perhaps be more useful to humanity than all the congresses of sovereigns and all the speeches of diplomacy. If it were known how small the earth is, perhaps man would cease cutting it to pieces. Peace would reign over the world, social wealth would take the place of the ruinous and shameful military craze, political divisions would be obliterated, and then only would men freely rise to the study of the universe, to the knowledge of nature, and enjoy the pleasures of an intellectual life. But we have not yet reached this point, and the photographic eye will reveal many celestial mysteries before the human eye sees reason and science establish their reign on our revolving ball. —*Paris Figaro; Photo. News.*

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